DRIVE SYSTEM TEST – PERFORMANCE AND POWER CONSUMPTION

CYBER BLUE – FRC 234 FALL SPECIAL PROJECT

Test Report / December 2014

INTRODUCTION

In the fall of 2014, Cyber Blue 234 completed a project to determine and compare the performance of multiple drive motor combinations to determine acceleration, top speed, power consumption and pushing performance.

The project was based around "Design of Experiments" methodology where there was a detailed plan and structure put in place to support the testing and isolate the key variables to improve the accuracy and conclusions of the testing.

For the testing, we used a single reduction gearbox, 2014 FRC legal motors, a special built chassis, and the new NI roboRIO and 2015 FRC Control System to capture data. We recorded encoder counts, voltage, amperage on each motor and a time stamp. The voltage and current were read from the new Power Distribution Panel.

This report is to highlight an "operational effect" we noted from a new (and desirable) feature of the new control system that disables output to the PWMs when voltage drops below 7V. The purpose is to keep the voltage high enough for the roboRIO to stay alive and communicating.

OBJECTIVES OF TEST

The full test report is published separately.

This specific test was to determine the load (Amps) when pushing against a solid wall. We selected the motor combination for this test to minimize wheel slip with our combination of gearing, wheel size and tread.

While performing this test, we triggered an operational effect of the new Control System that may be important for teams to consider.

TESTING INFORMATION

Robot:

Kitbot Style Chassis
4 Wheel Drive - Belts
4 CIM Total Drive (2 per side)
VEXPRO Gearbox, 7:1 Reduction
37 – 42 Tooth Belt Sprocket Step Up
4" AM Performance Wheels
Blue Nitrile Tread (McMaster-Carr)
Final Drive ratio ~ 7.95:1

Robot Weight ~140 pounds
Theoretical Top Speed (5300 RPM CIM) ~ 11.64 FPS

For this test, we placed the robot against a wall and used a game pad controller to slowly accelerate.

RESULTS

As we progressed through the testing, we noted the robot seemed to be trying to move, then there would be some slight wheel slip, then the motors would stop. Very quickly, the motors would restart. This cycle would repeat.

Looking at the data, we were able to see when the roboRIO was disabling the output to the PWMs when the voltage dropped below 7V.

POTENTIAL OPERATIONAL EFFECT

When the motor load was removed, the battery voltage would recover, and output to the PWMs would be restored. This cycle repeated.

The first plot below shows a time segment of slightly over 2.5 seconds. This plot shows AMPS v Time (left axis) and VOLTS v Time (right axis) for the time segment. When the first cycle started, we were near 250 Amps.

The second plot below shows a smaller time block of the same test data. The time block is approximately 0.5 seconds.

CONCLUSIONS

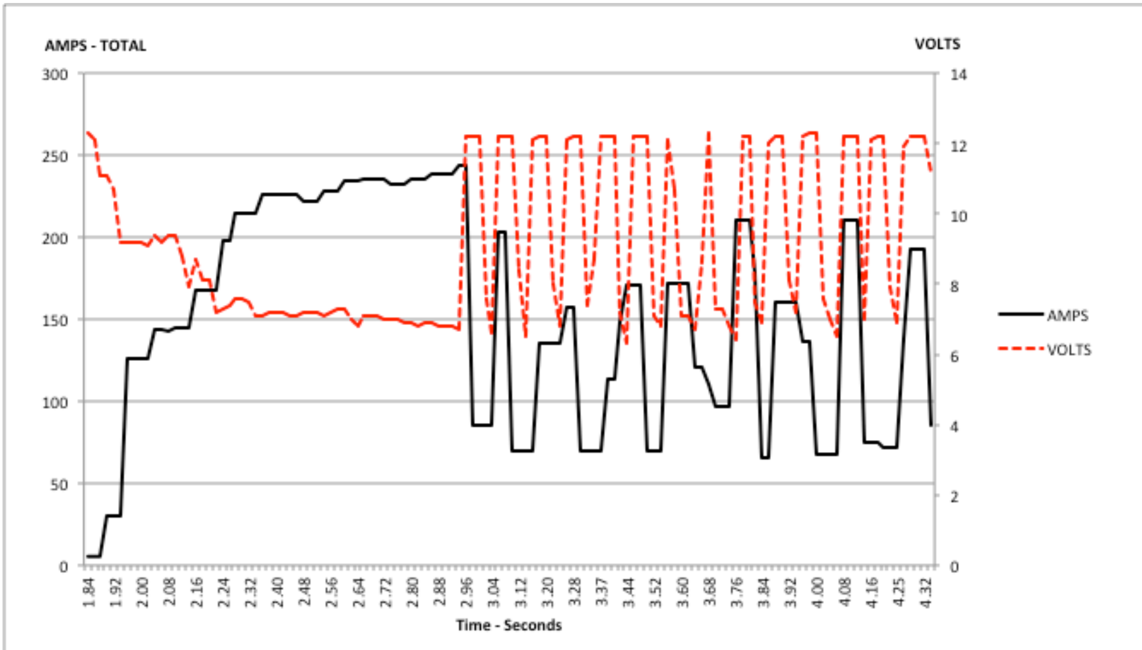
Our test was unique in that we were trying to push an immovable object (a wall), and we did not reduce our power demand when the PWMs were disabled (we kept the throttle at full power). This added to the quick cycling effect.

In an actual "pushing match" we believe there would be different reactions from the driver or other robots. When the "pushing" robot PWMs are disabled:

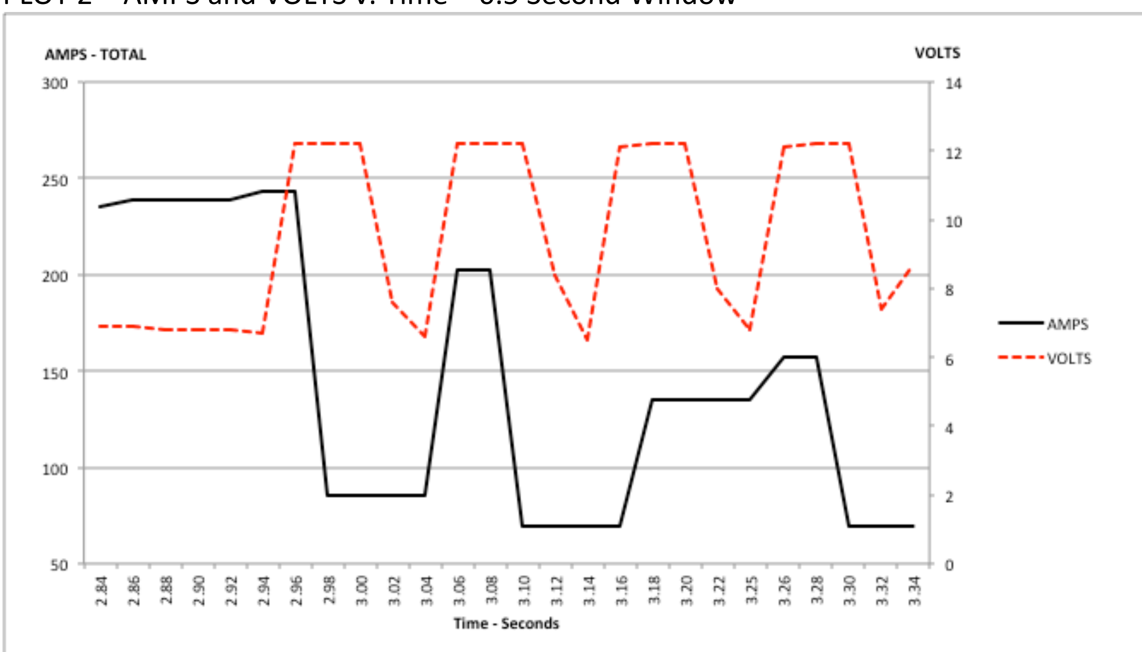
1. The pushed robot could move away.
2. The pushed robot could overcome the pushing robot.
3. The pushing robot driver could reduce power demands.
4. A team-implemented software "trigger" could alleviate the condition.

We have not drawn any conclusions about the operational impacts (positive or negative) from this data. It should be noted that with the 2014 control, voltage dropping to this level would likely have caused the cRio and radio to reboot, and the high amperages could have caused the main breaker to trip.

PLOT 1 – AMPS and VOLTS v. Time – 2.5 Second Window



PLOT 2 – AMPS and VOLTS v. Time – 0.5 Second Window



Our Interpretation: At time 2.94, the Voltage drops below 7V. Output to the PWMs is disabled, causing the load (Amps) to drop and then the battery voltage to increase (at time 2.96). The PWMs are re-enabled, increasing the load, and again reducing the battery voltage (at time 3.00 seconds). The cycle repeats.

Note: The data capture rate causes the Amperage to appear to be "flat" at the he max high and low points. Amperage is most likely going to "0" just not captured in timeframe of data capture.