Slippage Detection and Traction Control System
Product Test Plan

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I. Sensors
The sensors will be attached to the car by mounting brackets specific to the sensors. The brackets will be placed on the wheel-bearing housing and will allow the sensors to be adjusted to the correct sensing range. Once mounted they will sense the targets, which are the three bolts that attach the wheels. The sensors will be tested by applying +12VDC from either a DC power supply or from the vehicles’ battery and then rotating the targets, the bolts, within their sensing range. It will be clear that the targets are within the sensing range because the light on the sensors will come on. While rotating the targets, an oscilloscope will monitor the output signals from the sensors. The signals obtained should be square waves with magnitudes comparable to that of the +12VDC-voltage source.

II. MOSFETs
The Metal Oxide Semiconductor Field Effect Transistor’s (MOSFET) will be accepting the output signals from the sensors and will reduce the magnitude of the square wave from +12VDC to approximately 5VDC. The new voltage magnitudes will be safe for the microcontroller to accept as inputs. The +12VDC battery or voltage source via a linear voltage regulator will supply the 5VDC. An oscilloscope will monitor the voltage signal input from the sensors, which should show a square wave with a magnitude of +12VDC and compare this signal to the output signal, which should also be a square wave, with a magnitude of 5VDC.

III. User Input
The user input is a combination of a rotary switch and encoder, which allows the user to define the slip percentage that is acceptable. When the user input is changed it sends a signal to the microcontroller, which then implements a new variable into the existing code. This new variable will either increase or decrease the sensitivity to controlling slip depending on what the user chose. The user input will be tested by turning the rotary switch and viewing the output to the microcontroller input pins with an oscilloscope. From the oscilloscope, one should see a binary count, which is due to the encoding properties of the encoder. The binary count will come from two wires. The different combinations will be ‘00’, ‘01’, ‘10’, or ‘11’, which correspond to different slip percentages in the microcontroller. A ‘0’ is defined as a low signal and a ‘1’ is defined as a high signal. It will need to be switched repeatedly to test the endurance of the switch. This will establish the expected durability. The switch will need to be reliable since it is the system control.

III. Microcontroller & Code
The microcontroller will be tested using four frequency generators and the user input. The user input will be varied along with different combinations of frequencies on the four different wheel speed signals. The information that the microcontroller is receiving will then be displayed on a computer monitor to so that a simple comparison of the information collected and the frequency of the input signals can be made. Taking several
samples we will then use that information to see how accurately the microcontroller calculates the differences in the signals.

We also need to test what the max duty cycle can be without killing the engine. Using this information we can set the duty cycle for the above slip threshold slip signal. This is to prevent the traction control system from killing the engine, but still reducing power to the wheels.

**IV. Printed Circuit Board**
The printed Circuit Board will need to be tested to ensure that the right voltage levels are provided for the different components before connecting them to the board. The sensors need 12VDC, the MOSFETs and encoder need 5VDC, and the microcontroller needs 3.3VDC. First, the power supply will need to be connected and then the power pins of the microcontroller and encoder will be measured to make sure they are at the appropriate voltages. A multi-meter or oscilloscope will be sufficient to measure the voltage levels. The MOSFETs will also need to be tested to guarantee the signals from the sensors are at safe levels for the microcontroller, which will be 3.3 to 5VDC. Once every component is connected, the output level will be tested to ensure it will be enough to trigger the spark cut in the Engine Control Unit. The ECU needs at least 3.1VDC to produce a signal that will cut the spark.

**V. Engine Control Unit**
Applying a square wave with a magnitude of 3.3V to the digital input that is set to enable the spark cut will test the Engine Control Unit. Either the microcontroller or a function generator will supply the square wave. The result of the square wave input to the ECU will be viewed by the diagnostics system (DYNO) in the testing bay. The DYNO system has the capability to measure and display the RPM’s and Horsepower (HP) of the engine. While the square wave is high the ECU will cut the spark, which should decrease the RPM’s, which should in-turn decrease the HP and show how much power the engine loses due to the input duration.

The digital input’s affect on the engine has already been tested. A solid voltage level was applied to the digital input, which resulted in the engine dying. A voltage pulse was also applied to the digital input, and by sound only, it appeared to slow the engine.

**VI. Traction Control System**
The system will be tested by connecting and assembling all the parts, such as the sensors, MOSFETs, PCB, user input, encoder and microcontroller and connecting all of it to Engine Control Unit. The vehicle will be tested on the diagnostics system (DYNO) and possibly in the field. If the vehicle is not available for field-testing, individual steps in testing, like those described above, will be required. The vehicle may be on blocks, with the motor running, in which case the only wheels spinning will be the rear wheels. The sensor’s function will be demonstrated on the rear tires and viewed with an oscilloscope. To show the results of slippage in any tire, function generators will be used to represent the sensor’s output. This will give complete control in testing, by providing actual signals
that can be varied to simulate slippage on any one tire. One function generator signal can represent a tire that is slipping, while the other three function generators will imitate three non-slipping tires. The difference between the frequencies of the four function generators will be evaluated by the microcontroller, which will then send a signal to the ECU to cut the spark until the slipping stops. Of course, the slipping will only stop when the function generator is brought back to the frequency of the other three, but the vehicle’s RPM’s should fall until that signal is brought back.

If the vehicle is available for field-testing, the vehicle will drive timed laps with the system turned off and repeat the test with the system on. The driver will need to speed around corners in both tests to induce slipping to actually test the impact of the system. Reducing the lap time when the system is on should illustrate the success of the system.

Another test in the field will be to accelerate as fast as possible from a complete stand still with the system off, which should result in the tires spinning (slipping). Then the same test will be performed with the system on and it should be noticed that the tires don’t slip or slip much less.