P09222 Formula SAE Engine Control Unit
Test Plan

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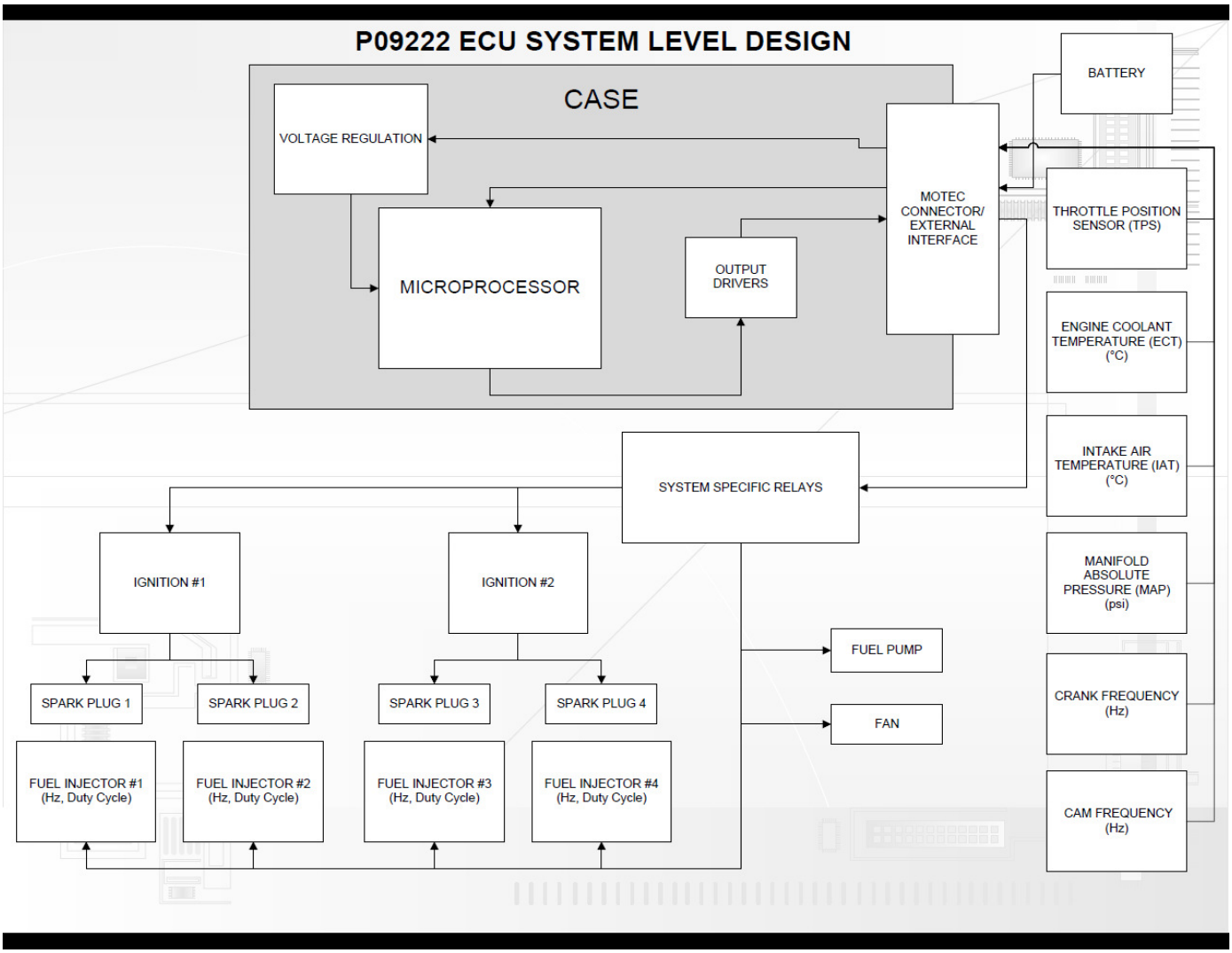
P09222 Formula ECU
Test Plans

Introduction

Add here or remove as applicable.

Project Description; Sub-Systems/ Critical Components Being Tested



Approval; Dr. Daniel Phillips, Dr. Alan Nye

Approved by:
Team Members – Dereck Bojanowski, Jordan Hibbits, Robert Joslyn, Bob Raymond, Andrew Rittase, Giovanni Sorrentino
Guide – George Slack
Sponsor – SAE Formula Team, Dr. Alan Nye

Test Strategies

NI DAQ Signal Production Testing – Input variables to verify

RPM – RPM specifications are entered manually by typing the desired value or increasing the value via the arrows in the labview program. Do not test at RPM=0, this will cause an error in the program. Tests will run from RPM=1 to 15000. Determine idle RPM for testing.

Manifold Air Pressure (MAP)- Manifold Absolute Pressure and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is red in color and matches the color of the graph on the sensor tab. This sensor reads the amount of pressure in the intake manifold and will send a 0-8V output to the ECU.

Throttle Position Sensor (TPS)- This is the Throttle Position Sensor and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is white in color and matches the color of the graph on the sensor tab. This produces a output between 0-5V, and will be entered in a percentage between 0 and 100%. When the Sensor is at 0% throttle it sends 0V and the throttle plate is closed. When it reads 100% throttle the throttle is wide open and sends 5V.

Intake Air Temperature (IAT) - Intake Air Temperature sensor and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is blue in color and matches the color of the graph on the sensor tab. This Signal tells the ECU the temperature of the air entering the engine and is in between 0-5V.

Engine Coolant Temperature (ECT) - This shows and stands for Engine Coolant Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is green in color and matches the color of the graph on the sensor tab. This will send a 0-5V signal to the ECU where it will determine if a correction is required.

Cam Offset - in this box you enter how many degrees the cam and crank are offset from each other. This value is in degrees and then the program converts it over to a delay in seconds.

Responsibilities: Bob Raymond, Giovanni Sorrentino, Jordan Hibbits

PCB Functionality testing

1.4.2.1 Verify Voltage Regulation

Provide +12V and GND to the ECU on the required pin using a bench power supply.
Using a voltmeter, measure the voltage at the output of the 1.9V, 3.3V, 5V, and 8V regulators.
Each voltage must be within 100mV of the designed value.
If voltage is outside required range, regulator should be replaced and retested. If voltage is very low or if the regulator is very hot, PCB should be checked for a short circuit.
Put a resistive load on each regulator to draw the maximum current that can be supplied by each regulator. Verify that the voltage drop does not exceed 100mV.
Testing is the responsibility of Robert, Andrew, and Dereck

1.4.2.2 Verify Microcontroller Operation

Once the voltage regulation is confirmed to be working, it should be verified that the microcontroller is operating as desired.
With the proper 1.9V and 3.3V supplied to the microcontroller, check to make sure that the I/O pins operate normally by running the software. This behavior will be determined by the software.
If microcontroller does not respond, check the software to verify operation. It is also possible that the voltage regulator did not initiate the proper start-up sequence. Use the TPS70302 datasheet and an oscilloscope to verify the proper startup sequence.
Microcontroller testing will be done by Jordan.

1.4.2.3 Fuel Injector Operation

The fuel injectors need to be tested to make sure that the ECU parts can handle operating them under full load. The correct timing of the injectors will be tested separately with the software and the NI DAQ
With the software running, run the fuel injectors at a maximum frequency of 140Hz for 5 minutes. The fuel injectors should run without failing wide open. The MOSFETs controlling the injectors may get warm, but should not get so hot as to cause damage to themselves or the board.
If the transistors are too hot to touch, measure the temperature of the components. The maximum operating temperature is 150C.
Should the temperature of the MOSFETs exceed the maximum temperature, additional cooling solutions will need to be created.
Testing will be done by Andrew, Robert, and Dereck

1.4.2.4 Ignition Operation

The spark plugs need to be tested to ensure that they can run continuously without failure. Timing analysis will be tested separately with the software and the NI DAQ.
With the software running, cycle the spark plugs at a rate of 140Hz for 5 minutes.
The output of the ECU should cycle at the rate of the input.
If output fails, check to make sure that the microcontroller and the buffer can handle the load being applied.
Testing will be done by Dereck, Andrew, and Robert

1.4.2.5 Fan and Fuel Pump Operation

Since fan and fuel pump are operated via relays, only the relays need to be connected to

the ECU. Connect both the fan relay and the fuel pump relay to the ECU.
First, turn on and hold the fan relay for 10 minutes to make sure that the ECU can handle constant operation. After 10 minutes, the relay can be turned off.
Next, turn on the fuel pump relay for 10 minutes. After 10 minutes, turn the relay off.
Since it is possible for both to be running at the same time, that will be tested next. Turn both the fan and fuel pump relays on and hold for10 minutes and then turn off.
The MOSFETs that control the relays may get warm, but should not get so hot that they damage themselves or the surrounding components.
Measure the temperature of the MOSFETs. The maximum operating temperature is 150C.
If the circuits fail due to heat, additional heat dissipation measures will need to be taken. It also may be possible to alter the PCB layout to aid in removing heat.
Testing will be done by Dereck, Robert, and Andrew.

Programming Testing

To test the analong inputs, all inputs, except for the input under test, will be held constant. The outputs (Injection start time/degree before TDS, pulse width, ignition/spark timing, and fan relay output) will be watched on NI-DAQ test bench as inputs are changed from 0 to 5V.

To test the timing of the outputs, the system will be connected to the NI-DAQ and will be tested at all RPM values (Cam and Crank frequencies). The pulse timing of the injector, and the spark advance time of the injector will be measured and compared with values measured from the current MOTEC system. The main loop will be tested using a "heartbeat" LED/GPIO. At the end of each main loop cycle, a GPIO will toggle. To accurately measure the main loop duration, interrupts will be disabled for initial testing. The software will also be tested for responsiveness; that is, how quickly it reacts to changes in RPM (Cam/Crank frequencies). This will be done by sweeping the frequency of Cam and crank inputs, and measuring the changes in injector and ignition timing. The requirements for this are TBD. Timing requirements: Injector PWM, Ignition, Main loop (<400 ms), Responsiveness

Equipment needed: NI-DAQ test bench