Item 3- Motor Characterization and Dynamic Modeling Reporting Analysis
To: LFEVY42016 Team
From: Dan Bolognini
Date: 5/11/2016
Subject: Acceptance Test Report: Item 3

SOW Req. #	Descrption	Team Member	ATP Item	P/F	Grade
R003: Motor Characterization and Dynamic Modeling Reporting Analysis					
R005a	Static Characteristics	Armen	3	P	/00
R005b	Dynamic Characteristics	Dan	3	P	90
R005c	Efficiency and Cooling	Armen	3	P	/oo
R006a	Physics Model	Dan	3	P	/00
R006b	Simulation	Armen	3	P	/00
R006c	Results and Conclusions	Dan	3	P	/00

Item Overview

Analysis report exists with summaries and discussion of data for static and dynamic characterization, as well as efficiency and cooling. Static data is represented in plots covering the full range of torque and RPM estimated for the fully integrated car. The estimates for this range are backed up by discussion that anticipates characteristics of operation for the car. Analysis report also describes the physics model, featuring a diagram of a Simulink model and discussion of results.

Configuration Diagrams

N/A

Detailed Procedure

Plots are included in a presented analysis report which shows static data across the estimated full range of torque and RPM for the fully integrated car. Supporting information is provided which reinforces these ranges. Plots are also present which are representative of the dynamic characteristics of the motor+controller system. Dynamic parameters are listed and any calculations are shown. A brief analysis of collected cooling data and calculations for efficiency is shown in the report. A list of assumptions has been prepared about the expected parameters of the fully integrated car. These assumptions include mass, frictional losses, compliance, and gear ratios. The data

included in these assumptions is included in a physics model, which is fully described and rationalized with motor + controller data for support. The diagram of a Simulink model which implements this model is shown, and plots of the simulation results verify proper implementation. A results and conclusions section is included which provides analysis of energy requirements, and estimates of maximum torque, speed, and accumulator current. This section also addresses vehicle efficiency losses, and best possible gear ratios. Optimum throttle operation for max efficiency, acceleration, and handling are listed.

How and why requirements are met

R005a: Static Characteristics
- Static data was collected in a report with constraints and torque/RPM ranges determined
    - Torque
    - Power supply voltage
    - Power supply current
    - Motor RPM
- Analysis report exists which presents the static performance curves of the vehicle with constraints of the dynamometer and motor discussed.
    - Torque vs. RPM graph included
    - Ranges determined based on operating region for motor + dynamometer tests
    - Pass/Fail: Portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature	5/10/16	Pass
	Date	Pass/Fail

R005b: Dynamic Characteristics
- Dynamic data is provided alongside a report analyzing the data and conclusions are discussed regarding the function of the vehicle in dynamic conditions.
    - RPM vs. time
    - Torque vs. time
    - PS current vs. time
    - Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature	5/12/16	Pass
	Date	Pass/Fail

R005c: Efficiency and Cooling
- A report analyzing efficiency and cooling from static characterization is provided in the analysis report mentioned in R005a.
    - Temperature vs. time

- o Torque vs RPM graphs for cold and hot starting temperatures
- o Efficiency calculations based on input and output power (taken from static data)
- o Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature   5/10/16   Pass

Date   Pass/Fail

R006a: Physics Model

- Physics models are included which are based on assumptions made for mass, frictional losses, compliance, and gear ratios
  Models fully integrated car's speed as a function of throttle using parameters listed above
  Pass/Fail: portion included as part of full analysis report is accepted by professors
    - Explanations of parameters and how they were chosen
    - Math shown and supported for model

Witness/Examiner Signature   5/13/16   Pass

Date   Pass/Fail

R006b: Simulation

- A simulink model exists using the physics models and the parameters measured in R005.
  Pass/Fail: portion included as part of full analysis report is accepted by professors
    - Includes graphs of Simulink model simulations of speed vs throttle

Witness/Examiner Signature   5/13/16   Pass

Date   Pass/Fail

R006c: Results and Conclusions

- An analysis exists, similar that written for the requirements in R005, discussing new results and conclusions drawn from a more realistic vehicular model.
- The results and conclusions address efficiency, cooling, recommended gear-ratio, expected throttle limits, and optimal throttle operation.
- Address the following "Nadovich Questions"
    a. What is the full range of speed in mph that we can run the car at?
    b. How long will the battery last running the car?
    c. What is the best (efficiency) speed to be running the car at?
    d. What is the gear ratio we will be using in the final car setup?
    e. What is the maximum acceleration for the fully integrated car?
- Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature   5/13/16   Pass

Date   Pass/Fail

- Pass/Fail: "Nadovich Question" A addressed

  Witness/Examiner Signature   5/13/16   *Pass*
          Date   Pass/Fail

- Pass/Fail: "Nadovich Question" B addressed

  Witness/Examiner Signature   5/13/16   *Pass*
          Date   Pass/Fail

- Pass/Fail: "Nadovich Question" C addressed

  Witness/Examiner Signature   5/13/16   *Pass*
          Date   Pass/Fail

- Pass/Fail: "Nadovich Question" D addressed

  Witness/Examiner Signature   5/13/16   *Pass*
          Date   Pass/Fail

- Pass/Fail: "Nadovich Question" E addressed

  Witness/Examiner Signature   5/13/16   *Pass*
          Date   Pass/Fail

QA Tests and Test Memos

QAR005a - Static Characteristics
1. All specified data measured across full range of operation for torque and RPM
2. Data calibration/accuracy falls within specified tolerances

QAR005b - Dynamic Characteristics
1. All desired model parameters estimated
2. Accuracy analysis determines that parameters are calibrated correctly within proper tolerances

QAR005c - Efficiency and Cooling
1. Motor + controller efficiency and cooling requirements have been successfully measured
2. Tests comparing expected cooling system behavior to measured values are successfully completed

QAR006a - Physics Model

- Physics model output provides reasonable prediction of fully integrated system performance

QAR006b - Simulation
- Simulation is able to provide outputs expected by the generated physics model
- Working demonstration to professors successfully completed

QAR006c - Results and Conclusions
1. All data and calculations included in results and conclusions documentation falls within required tolerances, and model provided generates expected outputs for fully integrated system