

ENVE 2014: HIGH VOLTAGE

Work Package 2

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Contents

1 Tasks: Drive and Control

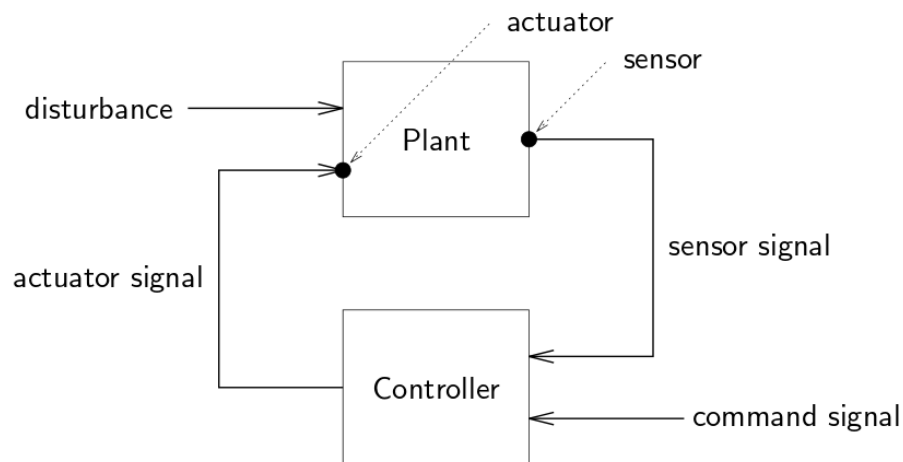
1. CAD schematics of feedback systems controlling the motor, how they work and how they are connected
2. A proposal for the control system including the gear involved. How the accelerator will be connected to the motor?
3. To speak with the REV team and any other team currently or that has built an electric car and ask them about HV related problems that they had and how they solved them

2 Control Systems Introduction

A little terminology; ¹

- The system to be controlled is called the *plant*
- The *sensor* measures the quantity to be controlled
- the *actuator* affects/changes the plant
- the *controller* or *control processor* processes the sensor signal to drive the actuator
- the *control law/algorithm* is the algorithm used by the control processor to drive the actuator signal

¹<https://web.stanford.edu/~boyd/ee102/ctrl-static.pdf>



2.1 Functions of Motor Control

Some function to keep in mind for the design of the motor control system ²

- Starting
- Stopping
- Jogging/Inching
- Plugging
- Speed Control
- Reversing
- Braking
- Protection

3 DC Motor Controls

Back EM Field Weakening control to achieve higher top speeds ³

4 BLDC Motor Control

BLDC control schemes are mainly classified in the following two types

- Sensor Based Control
- Sensorless Based Control

Not sure about this; google "field weakening control"

²<http://www.ohioelectricmotors.com/a-guide-to-electric-drives-and-dc-motor-control-688>

³http://web.eecs.utk.edu/~tolbert/power_electronics/pubs/Chiasson_publications_04.pdf

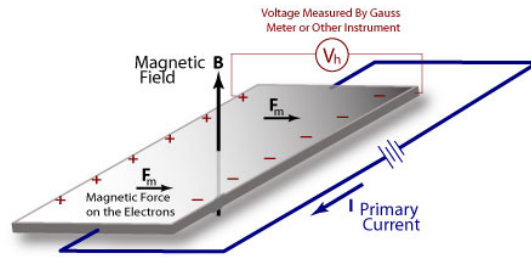


Figure 1: Hall Effect

4.1 BLDC Motor Sensor Control

BLDC commutation is performed electronically; The key to BLDC commutation is to determine the rotor position relative to the stator coils, and accordingly energize the phases in which will produce the most torque. Theoretically, and most likely practically, maximum torque is produced when the rotor is orthogonal to the alignment of the stator magnetic field. ⁴

Typically, a Hall sensor is used, which detects the position of the rotor magnet and gives a signal which is used to give appropriate excitation to the stator windings, as per above ⁵

Hall sensors work by virtue of the Hall effect (From Hyperphysics.phy-astr.gsu.edu); ⁶

If an electrical current flows through a conductor in a magnetic field, the magnetic field exerts a transverse force on the moving charge carriers which tend to push them to one side of the conductor...

This effect gives rise to the Hall voltage as seen in figure ??

Hall sensors are mounted in a regular pattern around the motor as seen in figure ?? ⁷

An important design consideration here, is to ensure there is no interference from the time-varying magnetic fields generated in the coils. Most setups follow the same layout as seen in figure ??; this is either due to the fact that the sensor measures field strength in a narrow linear axis or that the reluctance of the air is far greater than the reluctance of the motor chassis, allowing the motor magnetic field to permeate to the sensor without interference from the coils.

4.2 BLDC Motor Sensorless Control

⁸

1. Sensorless control is bases on the back-emf produced by the motor

⁴http://edge.rit.edu/content/P10022/public/team_docs/Files_To_Be_Deleted/team_docs/technical_literature/Brushless_DC_Motor_Control_Made_Easy.pdf

⁵http://www.academia.edu/7101951/MICROCONTROLLER_BASED_CONTROL_OF_THREE_PHASE_BLDC_MOTOR

⁶<http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/hall.html>

⁷<https://homes.cs.washington.edu/~todorov/papers/SimpkinsACC10.pdf>

⁸<http://scholar.lib.vt.edu/theses/available/etd-09152003-171904/unrestricted/T.pdf>

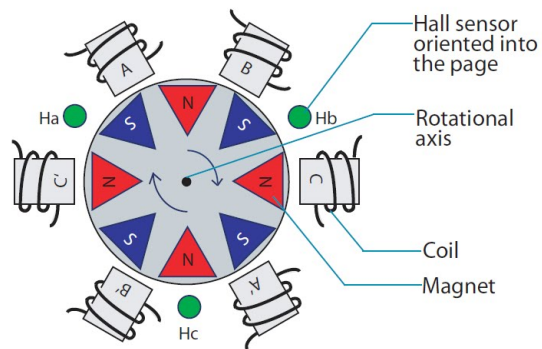


Figure 2: Hall Sensors Layot for BLDC Motor

2. There is a narrow range for which the back emf is sufficient to be detected