2016

iGP: Autonomous Car

iGP Module: Energy Management System for an Electric Vehicle

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Photovoltaic (PV) systems are receiving a wide acceptance in recent years as they are renewable energy resource, pollution free, and incorporate modularity feature. The power electronics interface plays an important role in delivering the adequate voltage, frequency, and power to the loads. The PV interfacing systems have incorporated great development in the last decades. Traditionally, the PV interfacing system comprises two main stages: a boost dc/dc converter and dc/ac converter. The main target of grid-connected PV system is to extract the maximum power from the PV module and deliver it to the grid by proper controllers of the associated power electronics converters. Therefore, the energy storage components are not necessary for grid-connected PV systems. However, for isolated loads, a storage components such as battery or ultracapacitor is necessary to satisfy the load power and to harvest the maximum power from the PV module.

This project is dedicated to implement energy management for a system including PV, batteries, and loads at the common DC bus (input to the DC/AC converter) of an electric vehicle. The students will build two different converters with two different controllers. One for the PV to absorb the maximum power using Maximum Power Point Tracking Controller (MPPT). The other converter is for the Battery to track the load power by fixing the DC bus voltage. This converter inherently Charge/Discharge the battery according to the generated power from the PV and the required load power.

Steps undertaken by the Project

1. Study the different types of PV interfacing systems
2. Select a proper topology for the boost DC/DC and buck-boost converters
3. Implementing a microcontroller code to generate the switching signals for the boost DC/DC converter to extract the maximum power from the PV module.
4. Selecting proper size for the battery and the proper topology for the buck-boost converter.
5. Implementing the energy management controller by regulating the common DC bus voltage using the battery interfaced by the buck-boot converter
6. Obtaining results that verify the operation of the system at different operating conditions.
7. Packing of the different components to make a practical prototype.
8. Writing the project booklet.

Project Challenges

1. Building a proper gate drive circuit.
2. Layout of the circuits to avoid the effect of noise and EMI with minimum space.
3. Troubleshooting the control circuits of the PV interfacing system before integration.
4. Tuning the controller on the chip to obtain the best performance of the PV interface system.