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## Performance Analysis on Power Train Drive System of the 2012 Toyota Camry Hybrid

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### Abstract

Cars and transportation system became an integral part of the human life. However, in these days, the energy issue is affecting the development of the car technology for becoming more energy efficient and environment friendly. One of the solutions is the hybrid car. This research is conducted to investigate how power train of hybrid electric vehicles works, in this paper we will observed power train drive system of the 2012 Toyota Camry hybrid. Things that will be investigated is how the hybrid system works to split the power depending to the driving conditions. Within this paper, using dyno dynamics test it will be investigated also performance of important components in the hybrid electric vehicle, like internal combustion engine, and PMSM electric motor in their power train drive system.

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Keywords : *Hybrid electric vehicle; Toyota Camry Hybrid 2012; power train drive system; internal combustion engine; PMSM electric motor; dyno dynamics test.*

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### 1. Introduction

Vehicles are essential part for human life. However, vehicle cause a big problem for the environment. Vehicles need fuel for operation, and the fuel is gasoline. This gasoline is non renewable energy, and now the oil reserve is getting low. This problem cause the price of gasoline to increase. Another problem is pollution. To reduce these problem, there are some solutions for vehicle development, alternative fuel vehicle, like hybrid vehicle and electric

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vehicle. Indonesia, one of the biggest developing country, and have million units of vehicle, seek this problem to be solved by having an electric car development program. ITB as one of the biggest technology institution in Indonesia that have this responsibility. ITB has built the electric car prototype, the recent program is researching hybrid vehicle.

Hybrid vehicle is one of the solution from energy issue today that demand efficiency of energy use. Hybrid vehicle is a vehicle using two different energy source for it propulsion device. These two energy sources are electrical source which is battery with electric motor, and gasoline fuel with Internal Combustion Engine for the propulsion device. This drivetrain produce less air pollution because use of electric motor.

However, there is some problem, hybrid vehicle drive train system is very complex compared to the conventional vehicle or the pure electric vehicle. The drive train system is very complex due to the use of combination of two power train system, electrical and mechanical. One of the difficulty is how the power of the car is splitting, because of two different fuel system, special mechanism must be done in solving this problem.

In this research, we test a hybrid car that has been sold to the public which is Toyota Camry Hybrid to knowing how it hybrid system work.

From the problems that we faced, we can describe some objectives of this research:

- Investigate how the hybrid vehicle works, and how to reach it maximum energy efficiency.
- Compare test result of the hybrid car with the specification given from manufacturer.

## 2. Hybrid Vehicle Explanation

### 2.1. Hybrid Vehicle Power Flow

Hybrid vehicle have complex power flow because of two different power source and propulsion device, then the hybrid system must have precise mechanism for achieving maximum efficiency. The picture below show the power flow diagram on the hybrid vehicle.

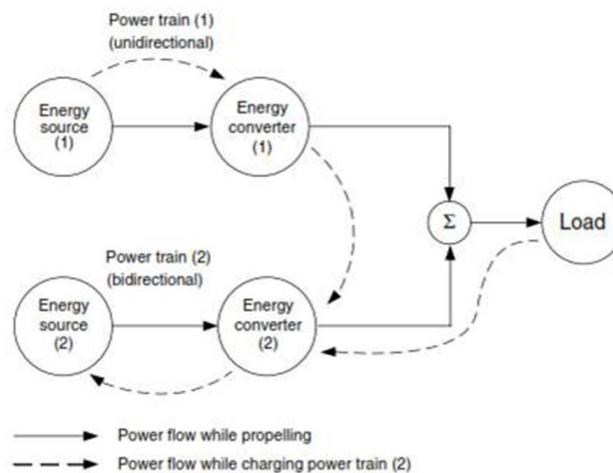


Fig.1 Power Flow diagram on Hybrid Vehicle[1].

From the picture above, can be concluded some work mechanism:

1. Power train 1 alone delivers power to the load
2. Power train 2 alone delivers power to the load
3. Both power train 1 and 2 deliver power to load at the same time
4. Power train 2 obtains power from load (regenerative braking)
5. Power train 2 obtains power from power train 1
6. Power train 2 obtains power from power train 1 and load at the same time
7. Power train 1 delivers power to load and to power train 2 at the same time

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