# Topology Selection

In the scope of this project, there are three main topologies come forward that are Flyback Converter, Forward Converter and Push-Pull Converter. All these topologies can be used between the high and low voltage batteries of Tesla Model S with an isolation mechanism. Also, all of these converter topologies give chance to adjust the output voltage with another parameter, turns ratio. Flyback Converter topology is created from the buck-boost converter topology with a transformer that helps to store the energy. The Flyback is the most common and most studied on topology. Therefore, there are lots of source and application notes for this choice. Although it is preferable for low power applications, the topology can supply the output current up to 10 A safely which is lower than the given specs of the project. Forward converter is created from the buck converter topology with a transformer. Like Flyback, Forward Converters are preferable for low power applications. In the magnetic design a gapless core can be used for Forward Converter design and this increase the Lm value which means less ripple at the output; however, due to extra inductor and diode cost could be higher than the Flyback converter. Also, in DCM mode gain changes dramatically. Moreover, MOSFET should withstand higher voltages which increases the size of the design. Forward Converters works stable even the exceeding 15 Amperes limit. Due to these crucial disadvantages, Forward Converter is not the selected topology. Push-Pull Converter is a kind of Forward Converter with two primary windings to create a dual drive winding. Utilization of the magnetic core is better compared the two other topologies, since in this topology the magnetic core can operate both 1st and 3rd quadrants of the B-H curve. On the other hand, switching control mechanism is harder than the other ones because as known both switches never should be activated at the same time. Moreover, Push-Pull Converters are better choice for very high-power applications. Considering the above criteria Flyback Converter topology is the best choice for this project. Furthermore, the engineers of Martian Power Solutions had some experience on designing Flyback Converter circuit and using these experiences results a better solution for this project.

# Operating Mode Selection

There are both advantages and disadvantages of the two operating modes, CCM and DCM. CCM is preferrable for high power applications while DCM is preferable for low power applications. Switching performance of DCM is better since the diode operates zero current just before the activating time. Also, transformer size in this mode is smaller; however, the peak and RMS value of the output current is higher than the CCM operation. This situation increases the stress level on the output capacitor and conduction losses on the MOSFET. Therefore, for the cases where the output has high voltage and low current DCM is a better option. On the other hand, CCM should be a better selection for the low output voltage and high output current. Furthermore, the controller is another important decision criterion of operating mode. Due to specs of the project, there are no lots of suitable controller or PWM generator selection in the market. LT8316 was chosen as a controller of this project and why this controller was selected is explained in XXX section in detailed. In the description of the controller, it can be seen that the IC has a pin called DCM pin. This pin detects the change of the voltage with respect to time () of the switching waveform and controls the operating mode by adjusting the duty cycle of the system. The aim of this control mechanism called critical conduction mode is operating the circuit almost in the boundary conditions since the controller improves load regulation without extra resistors and capacitors at the output side and reduces the transformer size with high efficiency at the boundary conditions. In short, the Flyback Controller with LT8316 operates at the boundary between the continuous and discontinuous conduction modes. To keep the operation at the boundary, switching frequency of the system is variable. Thanks to the controller, advantages of both continuous and discontinuous modes can be enjoyed in the design.