Abstract

As renewable energy resources become more involved in helping to provide today's increasing demand for energy, it is becoming more important to harness the maximum power that they are capable of transferring.

Maximum power point trackers (MPPTs) are used to ensure maximum power is transferred from a range of renewable energy input applications including thermoelectric generators (TEGs), photovoltaic panels (PVs) and inductive power transfer systems (IPTs).

One application in particular that would benefit with the addition of this MPPT is the new TEG being developed by BMW in conjunction with NASA which improves fuel efficiency and reduces CO2 emissions by up to 5% and is aiming to eventually replace the need for an alternator as it aims to produce enough electric power to run all the electrical components of the car. The energy and environmental implications of this will be huge, when taking into consideration that if successful, it could be applied to all vehicles (cars, lorries, etc) around the world, which is a massive reduction in oil consumption, and big improvement in energy efficiency as it re-uses the heat escaping from the exhaust in order to provide power to the vehicle. Considering that around 60% of the energy generated by a typical internal combustion engine is lost, half by heat absorbed by the engine cooling system, and the other half lost via exhaust heat, thus by reusing this exhaust heat the efficiency of the engine can be significantly improved.

Accurate current sensors are one of the most expensive components used in MPPTs, therefore there is a significant cost advantage in removing them from the system. There exists some scepticism as to whether or not there is a trade-off in accuracy against cost; however studies have been inconclusive due to some conclusions being contradictory.

Although there are other methods of current sensorless MPPT available, there has been no evidence that any of these methods have been tested on a boost converter operating in discontinuous conduction mode and has the ability to provide load and output voltage variation without affecting the control method for an input application with an approximately fixed internal resistance.

This project therefore proposes a new maximum power tracking control method which is being developed for a boost converter operating in discontinuous conduction mode without the use of current sensors, which allows for load and output voltage variation without affecting the control method.

An impedance matching method has been developed for a closed loop digital control system in order to provide MPPT for input applications that have an approximately fixed internal resistance such as TEGs and IPTs. The method has been analysed and subsequently used to design and construct a prototype converter with a microcontroller used to perform the control. Simulation and experimental verification have proved the method to be successful and further work has been suggested for a modified model which would be suitable for input applications that have a variable internal resistance due to temperature, light or both such as PVs.