NEWCASTLE UNIVERSITY UPON TYNE

Newcastle University can trace its origins back to 1834 and is now in the top 1% of world universities (QS World Rankings). We are member of the Russell Group, the association of the 20 leading research-intensive UK universities and we have one of the largest European Union research portfolios in the UK. The Electrical Power Research Group (EP) is UK's most active academic research institution in research on novel electromagnetic devices, power-dense power electronics and derived systems, estimation and control methods and advanced smart grids. Research activities cover various applications such as small low-cost drives for household applications to high efficient high power multilevel converters. EP is very active in automotive, aerospace and smart grid applications, working closely together with OEMs, Tier 1 and Tier 2 suppliers on new cost-effective solutions. The Group comprises 14 members of academic staff, supported by approximately 22 Research Associates and 50 PhD students, with a strong record on publications, patents and exploitations. 60% of our project funding comes directly from industry and EP's role is to assist industry in the creation and maintenance of market lead new products.

High efficient drive for a solar powered plane

Power module for a fault tolerant drive

Example 1: Power dc/dc converter – Project ongoing. This project addresses the need to build smaller passive components for power dc/dc converters. Traditional techniques are making use of high switching frequency devices or are developing new materials to reduce the size of passive components. Regrettably, these solutions are leading to high cost and suffer from the unknown of reliability data. EP developed a step-change in designing dc/dc converters by introducing new design rules. These design rules led to a new and simple control method that keeps the output voltage and inductor current stable even at a reduced inductor size. Work presented so far shows a reduction in the inductor size of a dc/dc converter by 50% only by changing the control algorithm but without the use of new materials or increasing the switching frequency. Therefore this technique is seen as a cost-effective method to reduce the size and weight of passive components.

Example 2: Lifetime enhancement of power modules – Project ongoing. The lifetime of power modules is determined by the junction temperature cycle. In order to increase the lifetime the junction temperature swing must be reduced. EP has developed a power module adopter that can be placed between the baseplate of the power module and cooling element. This adopter is changing the local thermal impedance actively for each individual chip. This allows full active control of the junction temperature for each chip, thus reducing the temperature swing. A 30% reduction of the temperature swing can be observed with the potential to go up to 70%. The adopter communicates with the gate drive circuit directly and impinges the cooling fluid in a controlled manner without the use of a mechanical pump.

Inverter for a doubly-fed induction generator