Modular, Multilevel High Power Converters

Increased efficiency and performance from modular multilevel converters reducing costs of converters for grid-level power systems and large motor drives.

The Challenge
The use of modular multilevel converters (M2LCs) has increased recently as the cost and availability of individual semiconductor devices is restrictive in high power applications. M2LCs are a low cost alternative, utilising available lower power semiconductors to meet required high power demands, in a modular, scalable fashion. Difficulties arise in the implementation of M2LC systems, particularly circulating and balancing currents, which leads to an increased rating of individual components and a need for complex voltage balancing control algorithms. Additionally, the control of, and power supply to, each separate module becomes a limiting factor as the number of modules increase. The failure of a single module can compromise the entire system.

The Solution
Researchers at the University of Auckland have implemented a number of methods to alleviate these difficulties, making M2LCs an efficient, economical and reliable choice for high power applications. Several techniques are in commercial use. An inductive power transfer (IPT) system “partially and wirelessly” transfers power to each module, using standard components, maintaining consistency and reducing circuit complexity while providing electrical isolation. A voltage correcting module (VCM) minimises voltage fluctuations across modules, countering the difficulties associated with circulating currents and reducing associated power losses.

Competitive Advantages
- Reduced Costs: IPT technique maintains high quality output with minimal complexity and galvanic isolation – at a fraction of individual module ratings.
- Reduced Costs: VCM technique reduces power losses and harmonic distortion of load currents enabling a substantial reduction in capacitor size compared to known M2LC solutions.
- VCM technique allows independent voltage control with simplified algorithms, unaffected by the number of modules included, maintaining scalability.

Applications
- High power motor drives
- High-voltage direct current (HVDC) transmission
- Traction motors
- Static synchronous compensators (STATCOM)
- Battery energy storage systems
- Grid-connected converters.
Power Electronics Research Group at The University of Auckland

Researchers in the Power Electronics Research Group within the Department of Electrical & Computer Engineering at The University of Auckland are involved in the development of inductive power transfer (IPT), motor control, electric vehicles, power electronics systems and magnetic modelling. Within the IPT space, the Power Electronics Group is arguably the recognised world leader in medium to high powered systems. Associate Professor Udaya Madawala and his team of researchers are working on commercially-focused development and research projects in relation to low cost electricity generation and management of sophisticated battery systems associated with IPT and other systems. Dr Madawala is a Senior Member of the IEEE and teaches both undergraduate and postgraduate courses in power electronics, electrical machines and heavy current electronics.

The University of Auckland

The University of Auckland is New Zealand’s leading university and is the only one ranked among the world’s top 200 universities by the Times Higher Education World Rankings of Universities. It is also the highest ranked New Zealand university in the QS World University Rankings and the Shanghai Jiao Tong Academic Ranking of World Universities. The University of Auckland is an international centre of learning and academic excellence. It is New Zealand’s pre-eminent research-led institution and has key linkages with many of the world’s top research intensive universities. Based in the heart of New Zealand’s largest and most diverse city, The University of Auckland has the most comprehensive range of courses in the country. The University’s mission is to be a research-led, international university, recognised for excellence in teaching, learning, research, creative work and administration. The University actively seeks to work with government, other universities, research organisations, businesses and commercial consultancies in research, development and education.

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