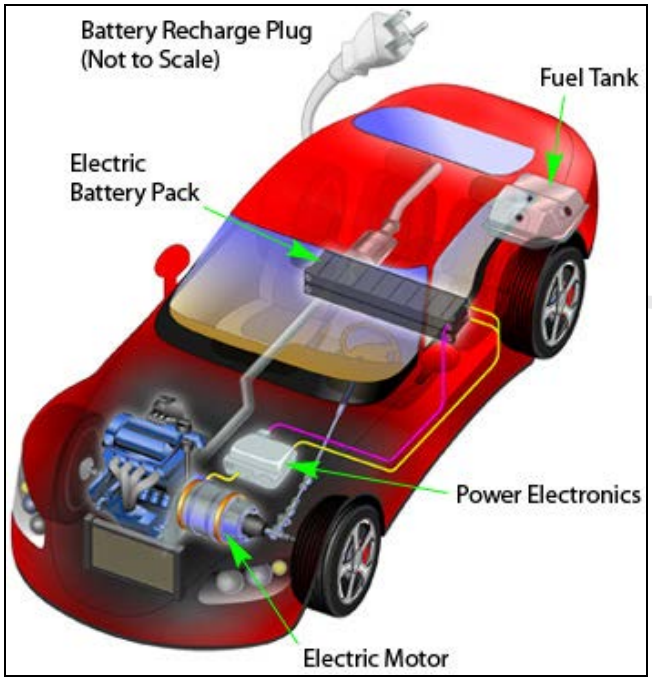
TECHNOLOGY FACT SHEET

ULTRA-FAST BI-DIRECTIONAL SOLID STATE CIRCUIT BREAKER

(Urciuoli)

Introduction

The invention relates to a two terminal, bi-directional scalable solid-state circuit breaker (SSCB) using wide band gap transistors which have been designed and experimentally evaluated. The concept includes a novel SSCB gate drive, and a bi-directional snubber. The invention can improve high speed bi-directional fault protection in a broad range of AC and DC power conversion and/or distribution systems



Dynamic, complex electrical systems such as plug-in electric hybrid vehicles would benefit from the SEDD innovation (image source: SEDD)

Concept

A new gate driver was designed, built, and successfully evaluated to enable an inherent hardware over-current protection feature for high speed scalable bi-directional solid state circuit breakers (BDSSCB). The gate driver was designed using a new method to sense current in a set of wide band gap transistors, and to provide proper gate control to transition the devices to the OFF-state. The driver also provides signal input lines for external SSCB actuation via manual control or control from the output of other sensors or devices. The gate driver was demonstrated in a scalable BDSSCB test circuit at a 600 V / 10 A fault condition and performed as designed in both external and current actuated modes.

Invention Overview

- *Novel gate driver provides temperature compensated inherent over-current protection*
- *Geared towards electric vehicle applications; military and commercial*
- *Smaller, less weight and improves system ruggedness/survivability*
- *TRL 5 – Functional engineering prototype*
- *Test results available from the inventor*

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Features/Capabilities/Intellectual Property

In many hybrid electric vehicle systems, AC and DC power components operate between two voltage busses having independent sourcing capability, and require bi-directional fault isolation. Because mechanical contactors do not provide adequate actuation speeds in many applications, and suffer severe degradation during repeated fault isolation, a solid-state circuit breaker (SSCB) is required. While mechanical switches/contactors provide interrupt speeds of tens to hundreds of milliseconds, SSCBs can provide fault current interrupt speeds in tens to hundreds of microseconds; representing 3 orders of magnitude improvement. Unlike mechanical fault protection devices which are limited to a few high energy fault interrupt events, this technology can provide in excess of 106 high energy fault interrupt events. The invention enables an inherent hardware over-current protection feature for high speed SSCB's and compensates for increased device junction temperatures.

Potential Markets/Applications

The technology is especially applicable to hybrid electric vehicle power conversion systems and electrical energy storage systems where bi-directional power flow is present and where fault protection is critical for mobility, and system support. From a military perspective, this invention is envisioned for use in military tactical and combat hybrid electric vehicles. Moreover, this approach can provide additional benefits such as smaller size, less weight, and dramatically improve the ruggedness/survivability of these types of vehicles. From a commercial perspective, the invention can also be applied to benefit the hybrid electric vehicle industry. Furthermore, this SSCB concept can be applied to provide fault protection in AC systems, DC systems, AC-to-AC power conversion and/or power distribution systems, AC-to-DC power conversion and/or power distribution systems, DC-to-AC power conversion and/or power distribution systems, and DC-to-DC power conversion and/or power distribution systems.

Key Advantages & Benefits

- *High speed fault protection (microsecond vs. millisecond)*
- *Inherent device temperature compensated over-current protection*
- *Improved reliability*
- *Solid state approach vs. mechanical switch*
- *Reduced size and weight*
- *Inventor available to work with commercialization partner*

Contact Information

This technology was developed by ARL-SEDD. It is now available for licensing and CRADA opportunities.

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