Current Status of Art

**CSA Report** Team DOPES

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18th October 2017

Impedance spectroscopy methods exist in the world of technology today. For power electronics, extensive patent and product research has revealed that current methods of performing spectroscopy are primarily limited to external monitoring devices such as the Hewlett Placard 4395A Network Spectrum analyzer, and the Agilent PNA-X N5245A Vector Network Analyzer. Devices with integrated spectroscopy methods are limited to use by liquids, as filed by Patent US7315767B2. It can be concluded that there are no current embedded devices or methodologies that are ingrained in power electronics to evaluate their health.

The global technological market is on the rise, with 50m tonnes of electronic devices being sold every year. As people and problems become more complex, a juxtaposing requirement for technology to become just as complex. The result in the advancement of said technology produces a higher reliance on power electronics because devices need to work harder and faster. This has implications for power electronics to work with increasing efficiency and failure mode detection for the incremental development and fixing of power electronics. It can be definitively said that there is a need for two of the following: 1) The mathematical characterization of failure modes in power electronics, and 2) A simplistic sensory network that can be embedded within current power electronic devices. The design project of DOPES seek to chip away at both these needs within the market. Initially, focus must be made to the first of these two scopes for the entirety of the need to be met. Therefore, much of the design project will be centered around firstly this characterization.

The current state of art for characterizing failure in power electronics relies on external probing methods. Failure, for the sake of simplicity, can be deemed as a function of impedance. Probing methods, such as that previously mentioned with the HP 4395A Network Spectrum Analyzer, determine impedance by applying an excitation element in the form of a voltage, and measuring the current through the element in correspondence to Ohm's Law. While accurate, this methodology is not practical for obtaining the same information from every day devices that are mostly within very small integrated circuits. Also, these excitation methods can alter the ultimate desired performance of a device. Our approach to this problem is revolutionary in two aspects; significantly reduction in size for integration into an existing power electronic device and also, the use of non-excitation methods to obtain different information to produce the same conclusion.

The dynamic nature of the approach of this design project is such that "kills to birds with one stone". The embedded sensory network will facilitate obtaining non-excitation based information such as temperature and magnetic field intensity. From this, the formulation of failure will be concluded. Additionally, a feedback loop of a correction measure such as current or voltage based on the failure conclusion can be integrated into the entire system as well. Although feedback loops are commonly used in the design of most electronic systems, extensive patent searches have revealed that there is no current existing embedded loop system that provides correction methods to power electronics based on failure information. This makes this project unique in that our work will contribute a significant cause of consideration that will guide an assist the development of technology.

As a result, the design requirements shall remain the same after this search. Further iterations of the final product will focus on developing an even smaller sensory network system. The goal is to make the final product as small and as accurate as possible. With the other state of arts to solve this problem not being feasible in implementing (for our purposes), the DOPES design project will proceed to execute current design considerations.