Analysis of System Wide Distortion in an Integrated Power System Utilizing a High Voltage DC Bus and Silicon Carbide Power Devices

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The United States Navy is moving in the direction of utilizing more electrical applications in the ships of the future. One of the biggest examples is the integrated power system (IPS), whereby the propulsion system is powered by electric motors, unlike the current propulsion systems that utilize gas turbine, diesel, or steam via a direct mechanical link. Combat systems and weapons of the future will also require even greater amounts of power than today while more equipment is being converted from mechanical to electrical applications.

Current research is ongoing into the development of power electronic devices that have high power capabilities. Silicon Carbide (SiC) power electronic devices are currently being developed and implemented for use in high power shipboard applications. SiC switches have the advantage of being able to withstand a much larger blocking voltage and very large forward currents for use in power transformation applications (rectifiers and inverters). SiC switches are also very efficient due to their quick rise and fall times. Since SiC switches can withstand high voltage differentials and switch faster than silicon switches, the switching effects on the electrical distribution system were investigated.

This thesis will investigate the proposed use of using SiC switches in the power electronic converters within the power distribution system. Although only the effects of an electric propulsion motor was analyzed, this work can be used in order to assess the issues that will arise when using the same SiC devices for the combat system and other power systems throughout the ship. This research investigates the distortion on the electrical distribution system for a high voltage DC IPS. The power supplied to the system was from a 20 MW synchronous generator. This supplied power was rectified to 10 KV and supplied to the propulsion system inverter. The analysis was concentrated on the distortion to the 13.8 KV AC power supplied from the generator due to the switching effects of the simulated SiC switches.