High Voltage EEE Parts for EMA/EHA Applications on Manned Launch Vehicles

ABSTRACT:

The objective of this paper is an assessment of high voltage electronic components required for high horsepower electric thrust vector control (TVC) systems for human spaceflight launch critical application. The scope consists of creating of a database of available Grade 1 electrical, electronic and electromechanical (EEE) parts suited to this application, a qualification path for potential non-Grade 1 EEE parts that could be used in these designs, and pathfinder testing to validate aspects of the proposed qualification plan.

Advances in the state of the art in high power electric power systems enable high horsepower electric actuators, such as the electromechnical actuator (EMA) and the electro-hydrostatic actuator (EHA), to be used in launch vehicle TVC systems, dramaticly reducing weight, complexity and operating costs. Designs typically use high voltage insulated gate bipolar transistors (HV-IGBT). However, no Grade 1 HV-IGBT exists and it is unlikely that market factors alone will produce such high quality parts. Furthermore, the perception of risk, the lack of qualification methodoloy, the absence of manned space flight heritage and other barriers impede the adoption of commercial grade parts onto the critical path.

The method of approach is to identify high voltage electronic component types and key parameters for parts currently used in high horsepower EMA/EHA applications, to search for higher quality substitutes and custom manufacturers, to create a database for these parts, and then to explore ways to qualify these parts for use in human spaceflight launch critical application, including grossly derating and possibly treating hybrid parts as modules.

This effort is ongoing, but results thus far include identification of over 60 HV-IGBT from four manufacturers, including some with a high reliability process flow. Voltage ranges for HV-IGBT have been identified, as has screening tests used to characterize HV-IGBT. BSI BS ISO 21350 Space systems — Off-the-shelf item utilization, developed from Marshall Work Instruction MWI8060.1 OFF-THE-SHELF HARDWARE UTILIZATION IN FLIGHT HARDWARE DEVELOPMENTwas found to provide guidance for including commercial off-the-shelf (COTS) hardware for use in critical applications.