High Frequency Design Considerations for the Large Detector Number and Small Form Factor Dual Electron Spectrometer of the Fast Plasma Investigation on NASA's Magnetospheric MultiScale Mission

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Each half of the Dual Electron Spectrometer (DES) of the Fast Plasma Investigation (FPI) on NASA's Magnetospheric MultiScale (MMS) mission utilizes a microchannel plate Chevron stack feeding 16 separate detection channels each with a dedicated anode and amplifier/discriminator chip. The desire to detect events on a single channel with a temporal spacing of 100 ns and a fixed dead-time drove our decision to use an amplifier/discriminator with a very fast (GHz class) front end. Since the inherent frequency response of each pulse in the output of the DES microchannel plate system also has frequency components above a GHz, this produced a number of design constraints not normally expected in electronic systems operating at peak speeds of 10 MHz. Additional constraints are imposed by the geometry of the instrument requiring all 16 channels along with each anode and amplifier/discriminator to be packaged in a relatively small space.

We developed an electrical model for board level interactions between the detector channels to allow us to design a board topology which gave us the best detection sensitivity and lowest channel to channel crosstalk. The amplifier/discriminator output was designed to prevent the outputs from one channel from producing triggers on the inputs of other channels. A number of Radio Frequency design techniques were then applied to prevent signals from other subsystems (e.g. the high voltage power supply, command and data handling board, and Ultraviolet stimulation for the MCP) from generating false events. These techniques enabled us to operate the board at its highest sensitivity when operated in isolation and at very high sensitivity when placed into the overall system.