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Large Input-Capacitance Compensation Method Employed in a CSA Designed for EMCs in HIEPA

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In this paper, a large input-capacitance compensation method is proposed in order to improve the performance of a CSA designed for electromagnetic calorimeter (EMC) in high intensity electron-positron accelerator (HIEPA), which is one of the options for the new generation of particle physics test facility in China. Charge Sensing Amplifier (CSA) is an important unit which can convert input charges into corresponding voltages. In advanced radiation sensing applications, high-resolution imaging as well as rare particles detection demands for detectors with large volumes or intercept area, which definitely bring large input capacitance to following CSA. When particles incident into the detector, the produced charges are shared between the detector capacitance and the miller equivalent of CSA's feedback capacitance. Generally, in order to achieve better noise performance, the feedback capacitance of the CSA is set to fermi farad, whose miller equivalent may hardly be comparable with the detector capacitance. Therefore, a large amount of signal charges shunt to ground through the detector capacitance and fail reaching the input node of CSA, which result in SNR degradation. Furthermore, the rising time of the CSA's output signal is also retarded as a result of signal loss. A capacitance compensation method is proposed in order to make the voltage of one capacitance plate varies with the that of the other plate, thus the detector (ideally) shows no capacitance to the input of the CSA. A unity-gain amplifier is carefully designed to execute the proposed method, in which, an output small signal current cancel-out technique is applied. Simulation results shows that the gain and bandwidth of the unity-gain amplifier are 0.019dB and 31MHz, respectively. The SNR of the CSA output is substantially enhanced by 4 times at the 270pF input-capacitance.

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