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An All Solid-State Inductively-Driven Radiation-Resistant Modulator For Fast-Kicker Magnet Applications

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In many accelerator applications requiring a fast-kicker magnet, radiation generated by particle beams can limit the physical proximity of the modulator to the magnet. It is typical that the modulator be located hundreds of feet away from the radiation environment, increasing the complexity and cost of the modulator and cabling.

The main susceptibility of the modulator to radiation-induced failure are the solid-state switches when they are in an open-state holding off high-voltage. By using an inductively-driven topology to switch DC current flowing through a considerable inductance into the kicker magnet, the time that high-voltage is across the solid-state switch is minimized and equal to the current rise-time and fall-time in the kicker magnet, thus increasing the MTTF of the modulator in the radiation environment.

The complexity of the primary energy source is also reduced to a low-voltage high-current supply that can be located with the controls away from the radiation and linked by simple high-current DC cabling. This method allows for an arbitrary pulse width and rep-rate as well as unlimited DC current in the kicker with no droop after the initial fast-rise.

Stangenes Industries has developed and installed the system described above to divert a proton beam in a medical application. This paper presents experimental data describing the systems' operational parameters as well as a novel switch protection scheme which prevents over-voltage failure of the switches.

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