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Design strategies for a SiC Marx generator for a kicker magnet

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Kicker magnets are specialised elements of the beam transfer system of particle accelerators, used to inject and extract beam from an accelerator. The deflection field produced by kicker magnets must rise/fall within the time period between the beam bunch trains; hence they typically produce rectangular field pulses with fast rise- and/or fall-times. In addition, the field must not significantly deviate from the flat top of the pulse or from zero between pulses. Typical field rise/fall-times range from tens to hundreds of nanoseconds and pulse widths range from tens of nanoseconds to tens of microseconds.
Most existing kicker systems at CERN rely on established technologies, which include thyratron switches and pulse-forming networks/lines (PFN/PFL). For thyratrons, long-term availability is a concern: hence alternate fast-switch technologies, based on high power semiconductor devices, such as the Marx generator are being actively pursued. A Marx generator topology would also potentially resolve problems associated with pulse forming: PFNs are complex devices built of many discrete components, difficult to adjust for optimisation of pulse-shapes, and PFLs rely on difficult-to-source cable for the highest voltage (≈80kV) kicker systems.
This paper presents design strategies and preliminary test results for a Marx generator with specifications of 40kV, 3.2kA, 3microseconds pulse width, 30ns rise and fall-times, and 1Hz repetition rate, for possible replacement of an existing kicker thyratron/PFL system. The proposed topology will use 50 stages, each 800V stage comprising 24 SiC MOSFETs in parallel, each MOSFET conducting almost 140A pulses. First tests using single and parallel SiC MOSFETs will be described and results discussed in light of the proposed topology. Also the structure of the complete system will be discussed, as the parasitic inductances are a key issue in this application.

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