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High Voltage Crowbar for Protection of Marx Trigger Generator (MTG) Systems on Z

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Triggering of high voltage Marx generators generally involves multiple stages, with the lower voltage signals associated with control systems being amplified to higher voltages to ensure operation with: high reliability, low jitter, and low probability of pre-fire. At the Sandia National Laboratories Z Machine, the trigger chain for the thirty-six Main Marxes includes a primary 100 kV laser triggered switch initiated by the Z control system (LTS100); which drives an array of nine Marx Trigger Generators (MTG); each of which triggers four of the Main Z Marxes. Each MTG consists of twelve capacitors which are themselves arranged in a Marx configuration to be able to produce an output pulse of 600 kV at full charge.

The advantages of the staged trigger scheme described above are considerable, but introduce the possibility of a failure mode where higher voltage systems can deliver energy back into the lower voltage trigger components. This failure mode has been observed on Z, with subsequent damage to both MTG capacitors and spark gaps. One way to prevent this failure mode would be to add a protection circuit, or crowbar, between the MTG output and the Main Marx trigger input. Such a circuit would need to prevent the nearly 6 MV maximum voltage on the Main Marxes from propagating back along the trigger line into the MTG(s).

A review of the available crowbar options/technologies for installation on Z will be discussed, along with subsequent tradeoffs and advantages of each type. Solid state, gas/vacuum switches, and liquid (oil) filled switches will be considered for the final design. The crowbar switch selected must not interfere with the normal trigger operation of Z, and must still be able to divert energy away from MTG components on a time scale relevant to the output risetime of the Main Marxes (˜1.5 µsec).

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