Power Electronics Based Pulse Power Generator for HV Testing

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***Abstract*-- High Voltage (HV) pulse power generators (PPGs) are widely used in several applications, among which is the HV insulation testing and routine tests. There is a potential of developing a new breed of PPGs based on power electronics converters designed specifically for this application as existing topologies are incapable of tailoring HV pulses precisely to a range of waveshapes. The controlled attributes of the HV pulses are: pulse width, peak voltage, frequency and shape. Generally speaking, a HV pulse with controllable rise, plateau and fall periods can be used to impress the standard voltage waveshapes on specimen used in these tests.**

Background & Main Results

High voltage testing labs are normally equipped with a range of high voltage testing apparatus used for insulation testing as well as routine testing of electrical power products (e.g. bushings, capacitors, cables and cable terminations, etc) [1]. Of this equipment is the impulse voltage generator synthesizing lightning and switching voltage impulses of magnitudes that can extend to the mega volts region. High voltage impulse generators are built traditionally with Marx generators. Other types of equipment include AC withstand voltage equipment and partial discharge measurement equipment.

Figure 1 HV impulse generator at TU Dresden

The use of advanced high power electronic devices to build these generators rather than passive components and arcing gaps offers multiple advantages; not least the enhanced controllability on waveshapes, slew rates (and thereby dv/dt stresses), and durations, allowing a wider range of precise test waveforms be impressed on specimen. Figure 2 shows an example circuit configuration that shows promise for utilization in impulse generators. It has the capability to not only manipulate the HV pulse characteristics, but also features a modular, fault tolerant, and a scalable design. In addition, the proposed topology comprises a buck-boost converter at its input, thus can be autonomously powered. As a result, it can relief the power grid from the associated harmonics from HV pulse generation. Figure 3 shows an exemplary train of pulses generated by the proposed converter applied to a resistive load of 1kΩ. Subplot (a) depicts the ±5kV pulses while subplot (b) shows ±300V pulses at repetition rates of 190µs and 240µs, respectively.

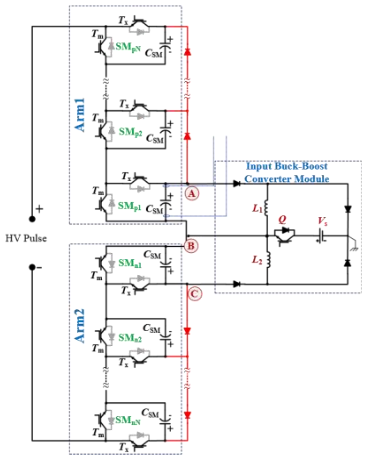

Figure 2:Proposed power electronics topology.

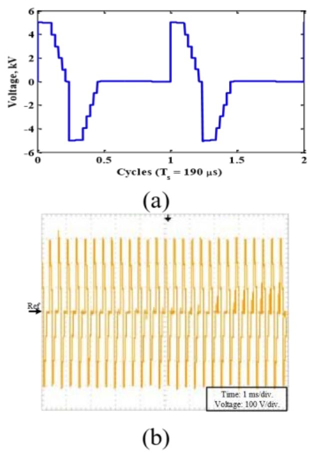

Figure 3: Train of controlled pulses (a) simulation. (b) Experimental.

Conclusions

Extending the topology given in Figure 2 to insulation testing is possible by exploiting the features of independent source energizing, modularity, controllability of waveshape, flexibility and scalability.

References

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