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A Modular 200kW-25kV DC Medium Frequency Resonant Converter for RF Power Amplifiers

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The energy upgrade of existing particle accelerators, and requests for more cost-effective solutions in new large scale facilities, leads to the need of more and more compact high voltage power converters for power amplifiers. Combining this with the increasing needs in terms of reliability, modularity and redundancy (availability of large accelerators), results in challenging power converter design efforts.. Topologies based on resonant LCC DC/AC converters connected to multi-secondary step-up transformers with series connected diode rectifiers generally offer good performances for such applications. Modularity can be achieved by using several multi-secondary windings medium frequency transformers with a high number of output rectifiers. This modular approach allows degraded operation with a faulty module. Moreover, using a soft-switched LCC resonant converter allows achieving a relatively high switching frequency leading to reduced step-up transformers volume.

This work focuses on the design of the high voltage stage of a modular 25 kV, 20 kHz resonant converter used to supplying a 200 kW RF tube. It addresses:

- *The high voltage stage design.* The number of secondary windings shall consider the diodes characteristics as well as stray capacitance and inductances. Designing such a high frequency and high voltage transformer for a power of 100 kW is challenging, issues and limitations are presented;
- *The diodes rectifiers' analysis.* The high voltage requirement leads to a large number of series connected/full bridge rectifiers. Diodes parameters dispersion such as the zero bias junction capacitance and the transition time play a key role in the diodes voltage distribution during the blocking state. This analysis shows how the diode should be chosen in order to avoid destructive overvoltages. Behavioral simulations are performed to illustrate the problematic.

The design analysis is complemented and compared with experimental measurements on a full scale prototype.

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