

**A dissertation entitled**

Harmonics and Instabilities in  
Thyristor Based Switching Circuits

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by

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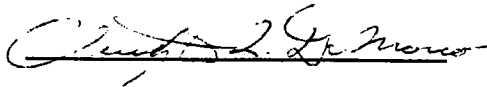
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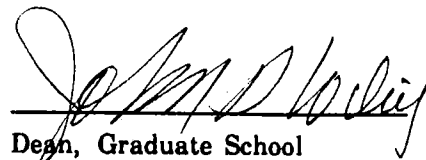
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# HARMONICS AND INSTABILITIES IN THYRISTOR BASED SWITCHING CIRCUITS

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Assistant Professor Ian Dobson at the University of Wisconsin-Madison

This thesis investigates nonlinear dynamics, harmonic distortions and bifurcation instabilities in thyristor switching circuits. The analysis is directed towards the study of a Thyristor Controlled Reactor (TCR) which consists of a fixed reactor and two oppositely poled thyristors. The dependence of the thyristor switching times on the system states causes the circuit nonlinearities and is the focus of much of the thesis. New concepts for instability, dynamic response and damping for TCR circuits are introduced. These concepts are general and can be extended to other switching circuits. Useful TCR circuit examples such as the 230 kV Kayenta advanced series compensator and the 230 kV Rimouski static Var system are used to numerically verify these concepts. We have found new instabilities in both the Kayenta and the Rimouski systems in which switching times change suddenly, or bifurcate as a system parameter varies slowly. Switching time bifurcations are associated with large distortions of the TCR current or voltage waveforms leading to a new earlier TCR current zero, the disappearance of a current zero, or a

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My numerous meetings with Professor Lasseter helped me to define the problem and to keep in touch with the practical issues regarding it. Similarly, my numerous discussions with Professor Dobson provided me with the theoretical framework required in solving this problem.

The past three years of working together has given me the confidence to become an independent researcher, for which I am thankful.

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