ABSTRACT

In recent years it has been revealed that all power electronic converters are strongly nonlinear systems, and the occurrence of bifurcations and chaos are very common in them. This thesis probes a few specific aspects of such phenomena in current mode controlled dc-dc converters.

There are two main operating modes of a dc-dc converter – continuous conduction mode (CCM) and discontinuous conduction mode (DCM). The nonlinear phenomena in dc-dc converters in CCM have been studied widely. The study of the converters operating in DCM has got relatively less attention. But no such study has been reported so far probing the bifurcation phenomena that occur when a converter shifts from one mode of operation to another. In this thesis we address this issue.

We obtain the discrete model of the systems including both CCM and DCM modes of operation, and show that the model is piecewise smooth with two borderlines dividing the state space into three smooth regions. We demonstrate that the change of system behaviour due to CCM-DCM transition can be categoized as border collision bifurcations with the special property that the system dimension at the two sides of the borderline are different. The theory to explain the bifurcation phenomena during mode transition has also been developed.

Another important aspect has been studied in this thesis. Most of the reported literature consider the idealized switching action. But in reality there is always a delay associated with every switching action, and the stray inductances and capacitances cause switching ripples. We show that these effects cause switchings to be missed, and if the model is obtained considering these non-idealities, then the map becomes discontinuous. This greatly affects the bifurcation sequences in such converters.

Finally, a current mode controlled buck converter has been fabricated and experimental studies have been carried out to validate the results obtained from simulation.