Abstract

High voltage dc power supplies have wide application range There are several challenging and unique issues to be addressed while designing these power supplies The Series Resonant Converter (SRC) is a preferred converter topology for high power, high voltage power supplies The advantages commanded by the SRC are a good compromise over its disadvantages The classical SRC is a frequency controlled converter Control can also be achieved by keeping the operating frequency fixed but varying the duty cycle Such an SRC is called the Phase Modulated Series Resonant Converter (PM-SRC) It possesses all the advantages of the classical SRC in addition to fixed frequency and light load operation capability Therefore, the PM-SRC is well suited for high voltage applications with a variable load

This thesis studies the PM-SRC for use in high frequency, high voltage applications Complete steady state analysis of the converter for operation above the resonant frequency is presented The ideal analysis results are used to identify favourable operating points and their boundaries Dynamic analysis of the converter is done through numerical simulation Circuit parasites in high voltage converters are too large to be ignored In particular, the high voltage transformer parasites affect the normal operation of the converter, often pushing the operation into unfavourable operating modes Their effects are analysed through both circuit based and numerical simulations

Zero Voltage Switching (ZVS) is the preferred soft switching method for high frequency converters employing MOSFET based inverters Though a suitable operating point facilitating ZVS can be chosen for a fixed load, ZVS is invariably lost for a changing load The ZVS range of the PM-SRC is studied and a new circuit to considerably extend the ZVS range is introduced Design relations for the new circuit are given

Another innovation for inherent short circuit protection for the SRC is introduced, analysed and tested The new method scores over the traditional methods of short circuit protection in that it is inherent and does not employ any current sensing or feedback circuits

A design procedure is evolved for the design of the PM-SRC The method tries to eliminate the influence of the high voltage transformer parasitics by suitable selection of operating points Fine tuning the design is done using circuit based simulations with all the known parasites included A 1kV, 200W PM-SRC operating at 100 kHz is designed, fabricated and tested to validate the design method and to test the new modified schemes