基于 FPGA 拉曼光纤放大器控制模块设计

电子科学与技术学院电子科学与技术专业　林小菊

（学号：2004111053）

指导教师：高致慧

摘要：光纤拉曼放大器（FRA）是利用受激拉曼散射（SRS）效应，以传输光纤作为增益介质的全光放大器，具有高带宽、高增益、高饱和功率、低噪声、分布式放大等优点，成为下一代超长距离、超大容量密集波分复用系统的关键技术之一。

本文主要分析了光纤拉曼放大器的原理、瞬态效应及进行了泵浦控制模块的设计。主要研究内容如下:

(1)介绍了光放大器的分类，重点讨论光纤拉曼放大器的特点、发展和应用。

(2)阐述了光纤拉曼放大器的基本原理，主要包括:受激拉曼散射、拉曼增益系数、拉曼阈值、增益特性和噪声特性等。

(3)分析了光纤拉曼放大器的增益瞬态效应和增益控制方法。

(4)进行了光纤拉曼放大器泵浦控制模块的设计，包括泵浦源驱动控制和 FPGA 监控部分。结合 FPGA，运用模拟和数字混合式共同控制激光器驱动电源。具体内容包括驱动源的总体设计、各部分电路的设计原理和 FPGA 片上系统设计。

关键词：光纤拉曼放大器；瞬态效应；泵浦控制模块；FPGA

Abstract: Fiber Raman amplifiers (FRA) are all-optical amplifier based on Stimulated Raman Scatter (SRS) generated in fibers, the gain medium of which is the transmission fibers. The advantages of FRA，such as wide bandwidth, high gain, high saturated out put power，low noise and distributed amplifying，are ideal for use as one of the key parts in the next DWDM transmission system with long-distance and large capacity.

In this paper，it mainly analyses the theories of FRA and researches the design of pump control modules in the system . The main research contents are given as follows:

(1) Optical amplifiers are introduced briefly, including the classifications and characteristics. Then it mainly discusses the FRA about the properties, applications and the recent developments.

(2) The essential theory of the FRA，including stimulated Raman scattering，Raman gain coefficient and threshold，gain and noise characteristics, are expatiated.

(3) The gain transient effects of FRA and its control method are analyzed.

(4) The design of FRA pump control modules is discussed in detail, including the driver control of the pump source and the SOPC control based on FPGA. Its control ways are using analog and digital mixed based on FPGA. The main contents are the whole design of the driver, the design principle of the partial circuit and the design of SOPC based on FPGA.

Key Words: FRA; Transient Effects; Pump Control Modules; FPGA

教师点评：本文较系统论述了光放大器的分类与特点，光纤拉曼放大器的基本原理与特性。通过分析光纤拉曼放大器的增益瞬态效应和增益控制方法，进行了光纤拉曼放大器泵浦模块设

计。系统设计基于 FPGA，运用模拟和数字混合式共同控制泵浦驱动。完成总体设计、各部分电路的原理设计和 FPGA 片上系统设计。

论文结构清晰，层次分明，书写规范。论文有一定创新与应用价值。本论文较好完成毕业设计任务书要求，达到了本科毕业设计论文要求。设计模块有待进一步验证与测试。