Building Blocks and Sub-Circuits for Magnetic Field Generators

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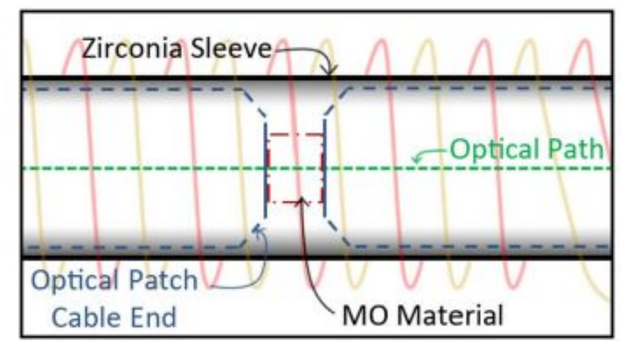
Introduction

Problem Statement

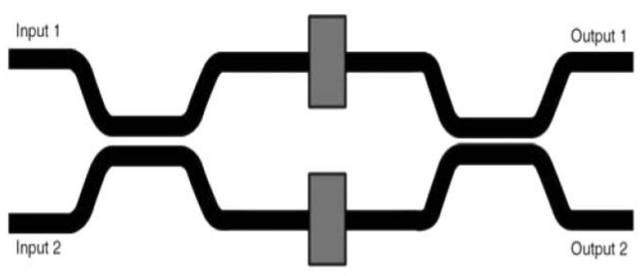
To improve previous senior design MFG circuit, creating a Zero Voltage Switching circuit to decrease switching loss, and creating our own optical simulation using MATLAB/Simulink.

Context

Our project primarily focuses on designing MFG/ZVS circuits while focusing on the optical design portion



MO material between two cables[1]



Mach-Zehnder loop[2]

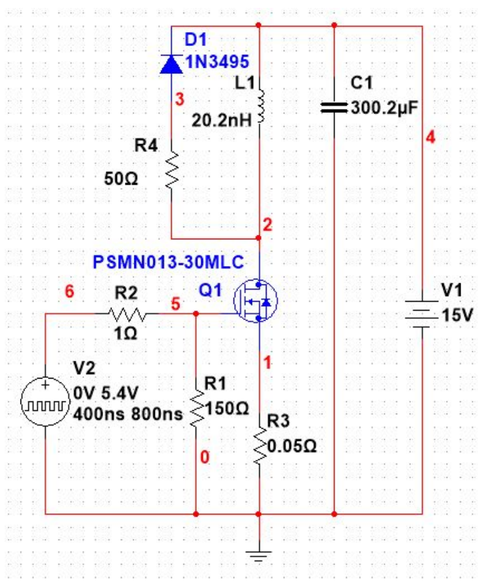
[1] J. W. Pritchard, M. Mina and R. J. Weber, "Improved Switching for Magneto-Optic Fiber-Based Technologies," in *IEEE Transactions on Magnetics*, vol. 48, no. 11, pp. 3772-3775, Nov. 2012, doi: 10.1109/TMAG.2012.2202275.

[2] J. -W. Tioh, M. Mina and R. J. Weber, "All-Optical Integrated Switch Utilizing Faraday Rotation," in *IEEE Transactions on Magnetics*, vol. 46, no. 6, pp. 2474-2477, June 2010, doi: 10.1109/TMAG.2010.2042433.

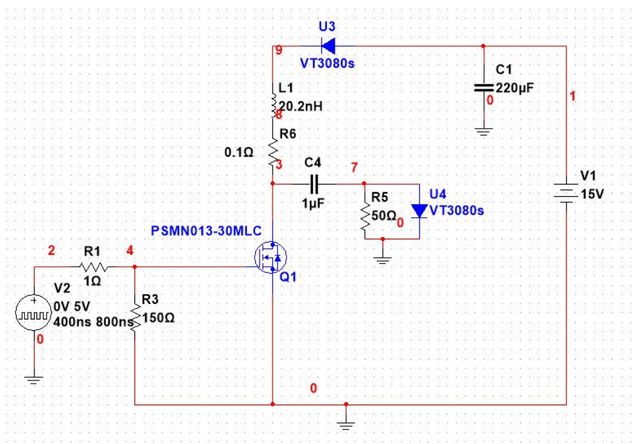
Circuit Design

Circuit Specifications

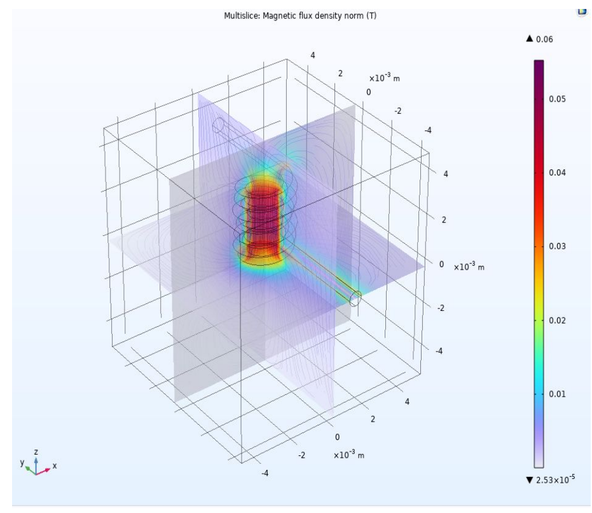
- 15 VDC
- 100 ns Rise Time
- 500 G Magnetic Flux Density
- 3.5” x 2” PCB



MFG Circuit



ZVS Circuit



ZVS Benefits

- Reduced Switching Losses

Results:

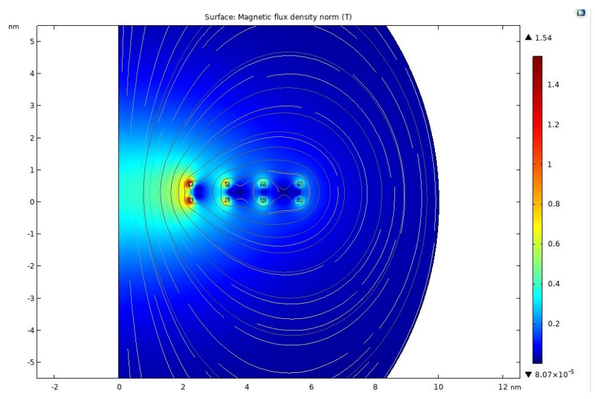
	MFG	ZVS
Rise Time (ns)	96	1,000
Current (A)	47	52
Flux Density (G)	569	630

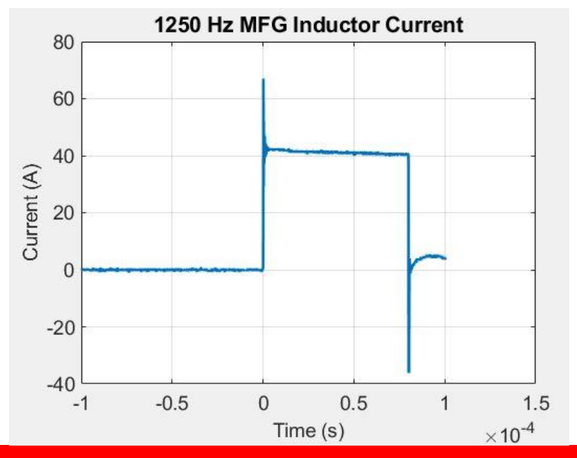
Inductor Design

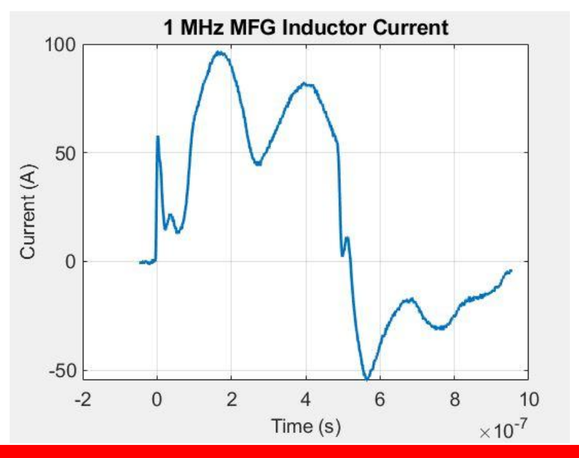
- N = 4 turns
- r = 1.1 mm
- l = 3.5 mm
- L = 20.2 nH

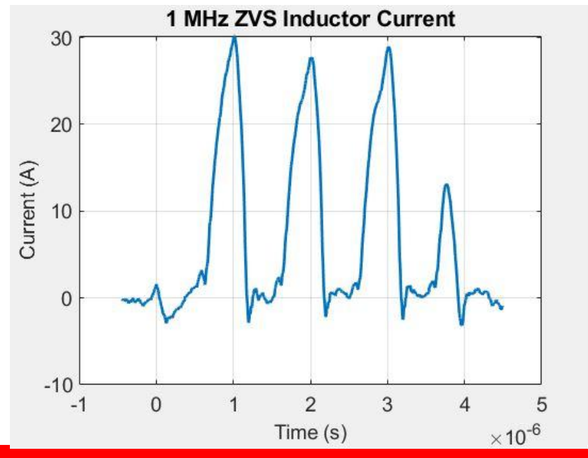
$$B = \frac{\mu_0 N I}{\sqrt{l^2 + 4r^2}}$$

$$L = \frac{\mu_0 N^2 \pi r^2}{\sqrt{l^2 + 4r^2}}$$







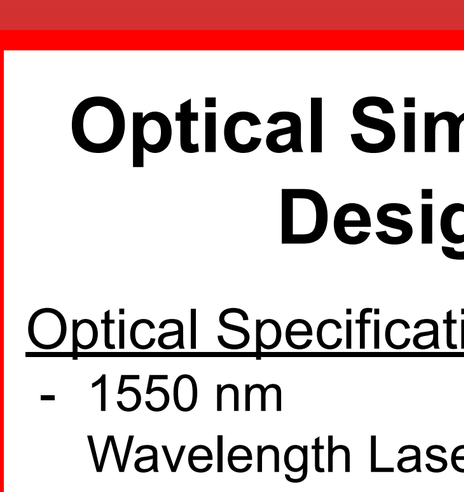


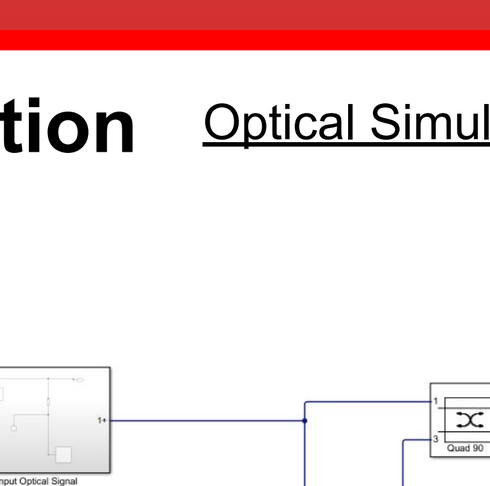
Optical Simulation Design

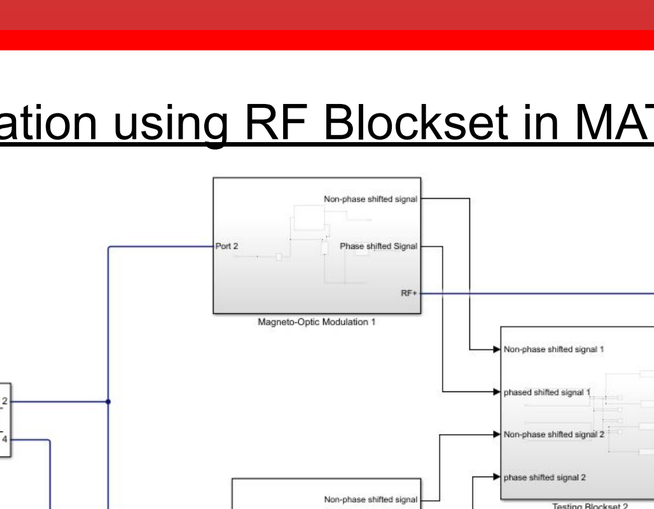
Optical Specifications

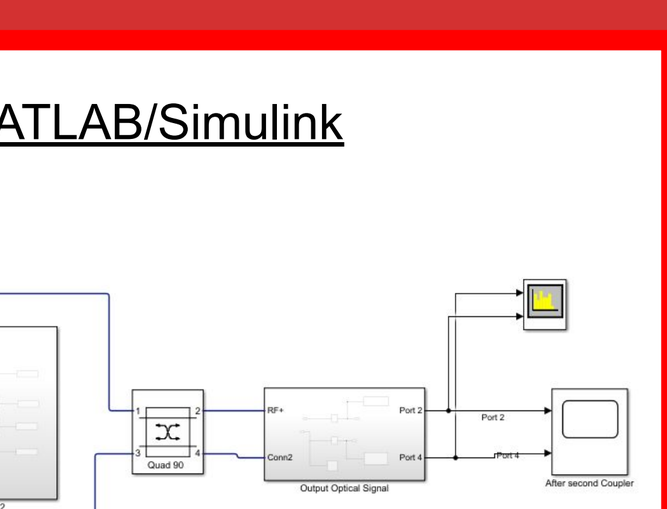
- 1550 nm Wavelength Laser input
- Quad 90 Coupler
- Lossless Simulation

Optical Simulation using RF Blockset in MATLAB/Simulink









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