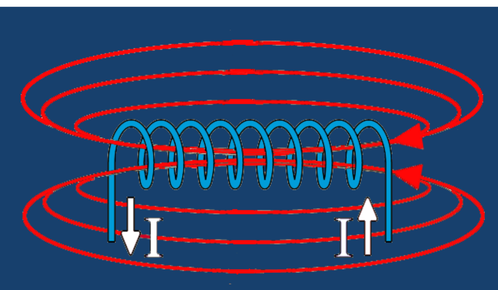
Fast, Compact, High Strength Magnetic Pulse Generator



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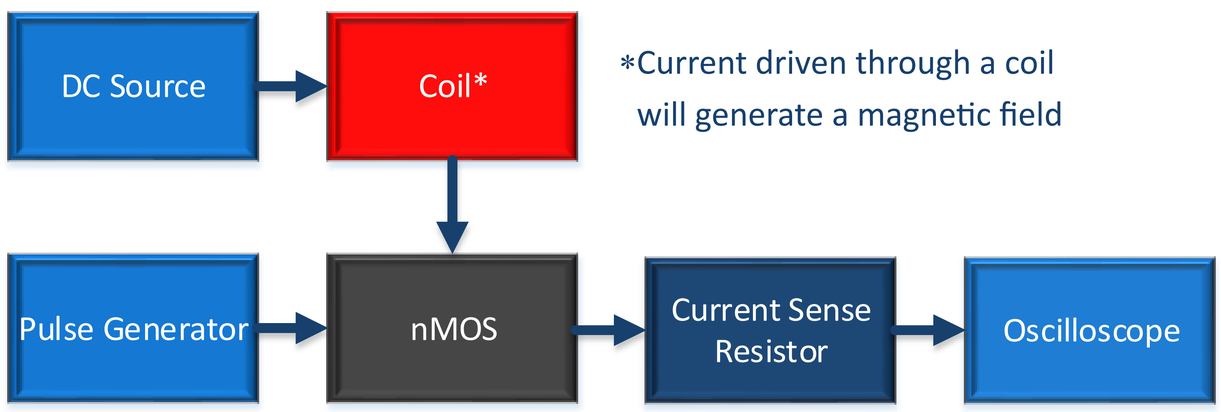
Problem Statement

As communication technology utilizing new magneto-optic materials advances, there becomes an increased need for small-scale, high-powered magnetic field generators. Few applications require small devices with such high current requirements at high speeds. This work presents a magnetic field generation circuit to be used in a research-grade fiber-optic switch with magneto-optic material.

System Block Diagram



*Current driven through a coil will generate a magnetic field

. Pulse generator sends one microsecond pulse to MOSFET
. MOSFET switches on
. DC current is drawn through coil
. Current sense resistor (CSR) needed to measure current through coil
. Oscilloscope measures voltage across CSR (0.05 ohm) and pulse width
. $I_{CSR} \approx I_{COIL}$
. Calculate magnetic field strength

Requirements

Non-Functional Requirements

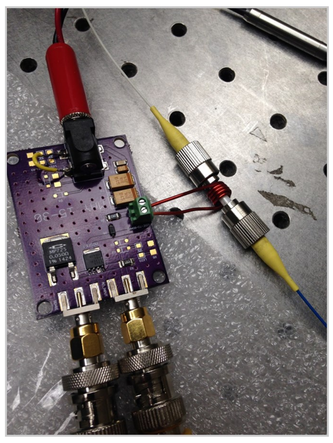
. Enclosure-ready
. DC voltage ≤ 15 volts
. Dimensions ≤ 3.5” (L) x 2.0” (W)
. Low cost

Functional Requirements

. Magnetic pulse ≥ 500 gauss
. One microsecond pulse

Coil Used for Testing

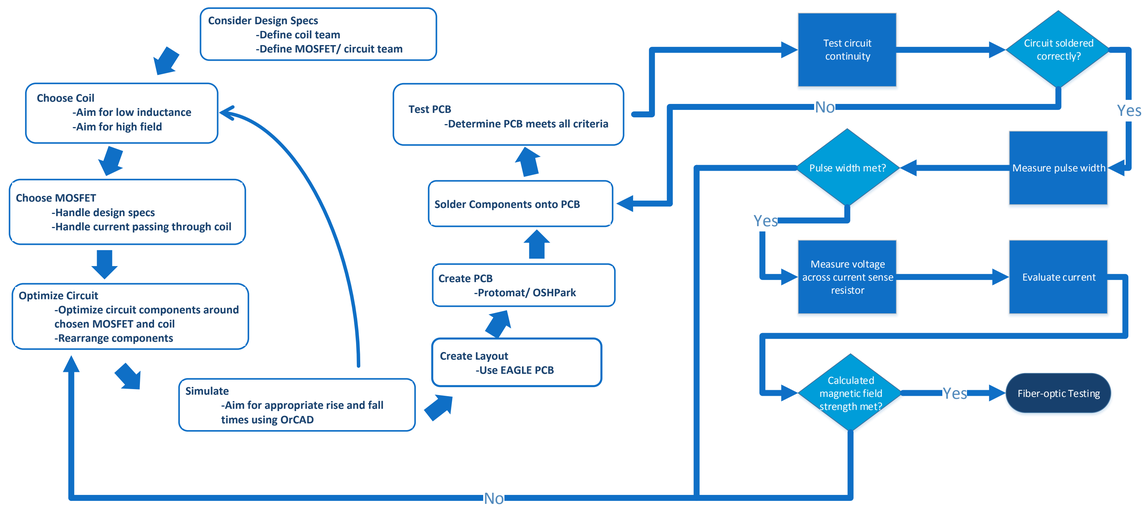
Applications



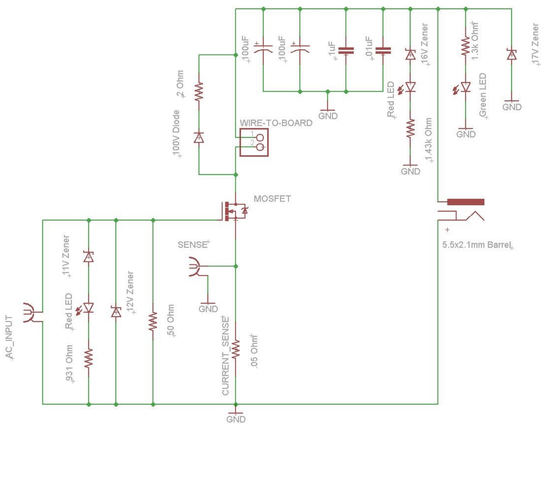
Circuit Magnetizing a Magneto-optic Element in a Fiber-optic Switch

. Small-scale fiber optic switches and routers
. Megawatt Q-switched laser systems
. Research in biomagnetism
. Small solenoid systems

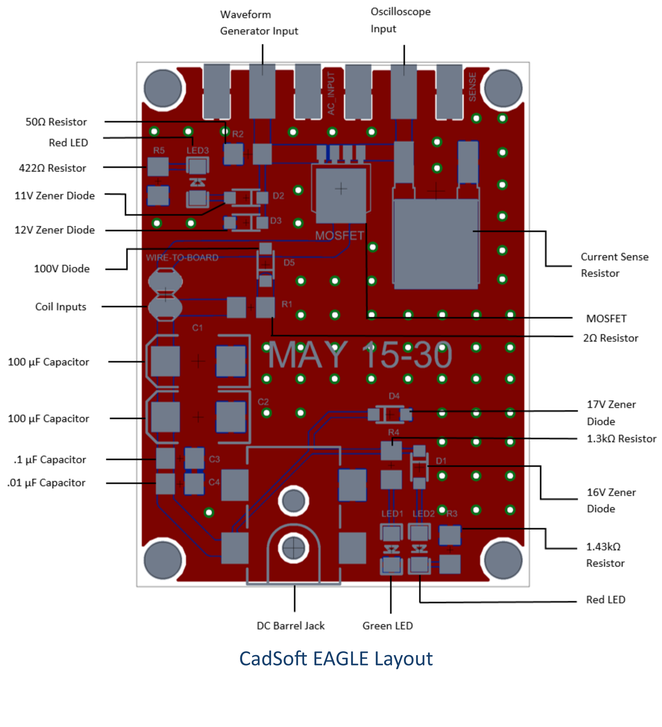
Design & Test Process



Schematic & Layout



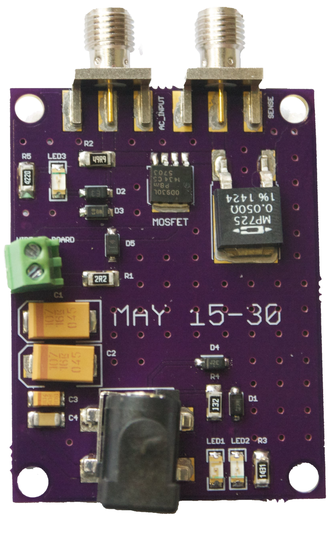
CadSoft EAGLE Schematic



CadSoft EAGLE Layout

Results

. Achieved 1 microsecond pulse
. Generated 500 gauss
. Consistent current with each pulse
. Scalable current by modifying input pulse magnitude
. Magnetic field generation circuit able to route optical signals in magneto-optic systems
. Total cost of parts and fabrication: $29.35
. Final dimensions: 2.0” (L) x 1.5” (W)



$$B = \frac{\mu N I}{\sqrt{l^2 + 4R^2}}$$

B = Magnetic Field Strength (tesla)
μ = Permeability (henries per meter)
N = Number of Turns
I = Current (amps)
l = Length of Coil (meters)
R = Radius of Coil (meters)