# Pulsed Radio Frequencies Using a Photoconductive Semiconductor Switch

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***Abstract* — Successful integration of Photo-Conductive Semiconductor Switches (PCSS) into existing pulsed Radio Frequency (RF) systems may yield higher switching speeds and power performance than current conventional system architectures, and realize significant size/weight reduction. Despite this, the feasibility of using PCSS technology to replace spark gap switches in pulsed power generators within a microwave system remains an area in need of investigation. This paper presents a comparison of an existing nominal system design to theoretical modified designs utilizing PCSS technology, via computer simulations based on existing data.**

***Keywords: pulsed power; RF; microwave; EMP, EMC, semiconductor, switching, solid-state, photoconductive***

## I. Introduction

Photoconductive Semiconductor Switches (PCSS) are solid-state transistor devices triggered into an *on* state from a normally *off* state by optical illumination [1]. They are typically made from semiconductor materials with wide bandgaps, which provide high electric field breakdown strength. This enables PCSS devices to be used in high voltage applications. III-V compound semiconductors such as GaN and semi-insulating GaAs constitute the primary material choices of interest for this paper [2]. By modulating the conductivity of these devices with a laser, the high voltage switching characteristics of traditional spark gaps may be reproduced or exceeded.

## II. METHODS

### A. Modeling the Control Design

A commercial off-the-shelf (COTS) high voltage RF pulse generator was modeled using CST Design Studio and Microwave Studio, a Finite Element Method (FEM) software package. The results from the computer model simulation were compared to known real-world results.

### B. Designing PCSS Modifications

The Semiconductor module of COMSOL Multiphysics, another COTS FEM software package, are used to accurately model and assist in designing a theoretical prototype switch, using a III-V nitride based device. Doping levels and device architectures are explored. Designs deemed feasible are modeled as equivalent lumped element circuits.

### C. Modeling and Comparison of Modified Designs

The lumped circuit equivalences of the new prototype switches are put into the original design's CST model and compared to the original performance of the design. Successive iterations and additional modifications to the design are implemented as necessary to explore the possibilities of PCSS devices in an indicative system, as well as what necessary alterations must be made to integrate the new technology. In addition, alternative antenna designs and alternative sources of pulsed power are explored in conjunction with the new capabilities of the solid-state switch. A complete systems engineering approach is used in order to accurately compare the theoretical system to the original. Measurement data from prior characterizations was used to supplement these findings.

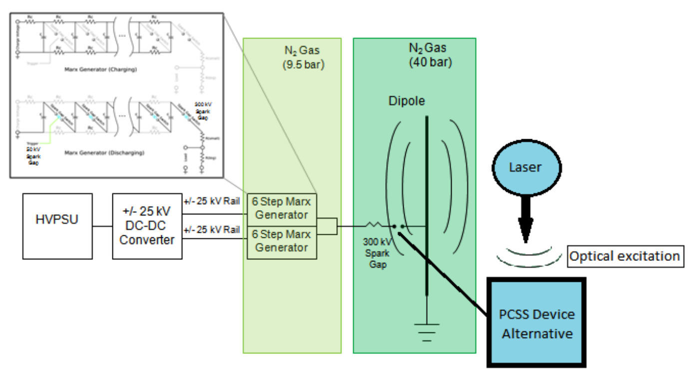


Figure 1. Original system and proposed modification

## References

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