PUBLIC ABSTRACT

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Title: Opto-Electronic Class AB Microwave Power Amplifier Using Photoconductive Switch Technology

Next generation land-based, mobile, phased-array radar systems for battlefield applications must meet constraints on volume, weight, power consumption, and data processing capability that are currently not available. The most inefficient component in a phased array radar system is the final power amplifier in each transmit-receive (TR) module. More recent final power amplifiers for TR modules have been configured in the Class AB or push-pull mode with a theoretical efficiency of 78.5% and an operational efficiency of only 20% at x-band (8-12.5 GHz) frequency. Note that an efficiency of 10% requires ten times the radiated power to be generated and 90% of the delivered energy to be removed as heat. In this dissertation, we present a new scheme of power amplifier, in particular, an opto-electronic (OE) Class AB push-pull microwave power amplifier. With this amplifier, high circuit efficiency and reasonable output power can be achieved at X-band (8-12.5 GHz) by utilizing a novel photoconductive semiconductor switch (PCSS) based on intrinsic GaAs instead of the traditional microwave transistors.

The performance of a photoconductive semiconductor switch (PCSS) based on intrinsic GaAs to prevent the lock-on effect for 10.0 GHz microwave application is investigated by Silvaco software simulation. The device is designed with a 0.1 μm width in the direction of photocurrent flow. The narrow 0.1 μm electrode separation distance is to ensure the fast removal of photocarriers by sweep out in the electric field associated with the applied voltage instead of the natural recombination time of photocarriers. The simulations show that the new PCSS can operate successfully at 10.0 GHz. When embedded in an OE Class AB power amplifier circuit, an optimum, intermediate value of the bias voltage V_{cc} can be identified for which the OE Class AB PA is more than 50.0 % efficient and produces output signals with very little distortion at 10 GHz. Finally, by stacking several photoconductive switches together (multi-layers structure), higher amplifier output can be achieved.