

# **SiGe High Speed Crossbar Switch for Digital Signal Router and Phased Array Antenna Systems**

by

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An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

DOCTOR OF PHILOSOPHY

Major Subject: Electrical Engineering

The original of the complete thesis is on file

in the Rensselaer Polytechnic Institute Library

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Rensselaer Polytechnic Institute  
Troy, New York

July 2009  
(For Graduation August, 2009)

## ABSTRACT

A wide band crossbar switch is a non-blocking signal router that can be used in various applications that need reconfigurable digital or analog cross connection such as for network switches, CPU-memory connection modules and wide tuning range radar switches. The purpose of this work is to assess the feasibility of implementing a high speed current mode logic using SiGe BiCMOS 8HP technology.

The crossbar switch comprises of multiple inputs and multiple outputs with an array of cross-points. When a cross-point is closed, it creates a connection between an input and an output. Current mode logic implemented in SiGe BiCMOS is used for the crossbar switch to attain high-frequency operation of the switch. CMOS has been a dominant technology in many applications. However it is slower compared to Bipolar or hetero-junction bipolar transistors (HBT).

The new crossbar switch in this thesis includes the following features: critical signals requiring high speed use HBT while slower signals use FET to save power; unused current trees are turned off for further power reduction; isolation multiplexer is applied to reduce jitter; equal delay through any path in the switch. Turning off the unused circuit reduces power consumption when only part of the switch is used. For the phased array antenna application, the entire core crossbar switch can be turned off while waiting for another signal to be pinged. A crossbar switch with equal delay to the each output is more attractive to WDM (Wavelength-Division Multiplexing) applications or serializer since all the data after the crossbar switch will still be aligned.

The crossbar switch in this thesis is implemented as a phase select module for a phased array antenna system. Phased array antenna systems use relative phases to the respective signals to form a beam pattern. Electronic steering features permit fast beam pattern rotation, and thus detect and track objects moving at high speed. The antenna can also perform reliably when placed on a high speed mobile platform. These advantages result in the technology becoming the focus of military and commercial applications.

The crossbar switch for phased array antenna system comprises of a decoder, registers, symmetric data path network with multiplexers and a multiphase voltage controlled oscillator (VCO). Sixteen differential phases are generated by an 8-stage LC

tank VCO and distributed to 8 antennas through the crossbar switch to form a proper beam pattern and steer the antennas electronically. The measured output of the crossbar switch is a 38.8GHz sine wave with the selected phase delay. The phase noise of the signal is -88.3dBc/Hz at 1MHz offset. Using a 2.5V supply the core crossbar switch consumes 2.2W to 5.7W depending the number of active channels.