September 28, 2020

Industrial and Federal agencies have sponsored my research projects and grants to develop solutions to antenna front end and direct digital receivers, a holy grail of telecommunication, remote sensing, radar, surveillance, surveillance, and target tracking. Most notably, among industrial collaborators has been SRI-Sarnoff Corp., Thales Air-defense Systems (TAS)-France, and Synergy Microwave Corp., in addition to National Reconnaissance Office (NRO), National Aeronautics and Space Administration (NASA)- Lewis Research Center, Army Communications-Electronics Command-Fort Monmouth, Naval Air warfare Center-Patuxent River, and Defense Advanced Research Projects Agency (DARPA) that have awarded research in microwave photonic technologies for performing functions of signal generation using opto-electronic oscillators, signal up- and down-conversion using opto-electronic mixing, signal distribution using fiber-optic distributions, and signal isolation and filtering using optical transversal filters. Of interest has been the challenge of all optical analog-digital convertors (AOADC) operating at sampling speeds of above 40GSPS with more than 8 effective number of bits (ENOB), and power consumption below 1W.

The approach of AOADC has been a major need of DoD that many organization have tried to implement. Of particular challenges have been development of an extremely low aperture jitters clock signal for optical sampling and an approach of spectral or spatial filtering. The former approach was pursued in a collaborative research with SRI that was sponsored by NRO, while the latter approach has been supported by TAS. Recent development of spatial light modulators (SLM) using leaky waveguide with 1D photonic crystal (PhC) has been pursued for a fully integrated realization on Si-Photonics integrated opto-electronics. Of particular interest is to employ electro-optic chromophores integrated with polymer optical waveguides to have an extremely broadband due to optical and RF velocity matched travelling wave structure combined with low-cost manufacturing of Si-Ge Bi-CMOS low-noise RF amplifier combined with SiC high-power RF Doherty power amplifiers as result of our collaborative efforts with SiCamore Semi LLC. The vision of an AOADC to directly convert received RF signals of over 25GHz bandwidth to binary digital codes with a similar signal-to-noise for all binary words. This technological breakthrough that is rooted on detailed analytical and numerical modeling with practical manufacturing steps will propel the opportunity of software defined radios (SDR) and waveform generators for jamming resilient radar systems and secure communications. The realization of all microfabrication process steps in-house leading to development of these types of devices in the United States of America will undoubtedly protect the country national security needs, provide novel intellectual property, and create future domestic manufacturing jobs.

These developments are essential to the future dominance of the Department of Defense and NASA missions for the next generation of opto-electronics, microelectronics, and photonic integrated circuits to accelerate the design, development, and manufacturing of key semiconductor technologies. Drexel University and SiCamore Semi, prioritized these projects to assure the technology is made available within a couple of years. Drexel University wants to thank Dr. Michel Francois, and Marc Papageorge of SiCamore Semi for their dedication and contributions to make this available to our programs of national interest.

Sincerely,

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