IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

Author: Dr. Aaron Pereira
University of Adelaide, Australia

ADVANCED MICROELECTRONICS FOR COMPACT INSTRUMENTATION MODULES FOR IONOSPHERIC SCIENCE

Abstract

CubeSats enable cost-effective exploration of the solar system and the possibility of providing topside measurements of planetary ionospheres. Earth's ionosphere enables long-range communication at medium and high frequencies (0.3-30MHz) and over-the-horizon surveillance radar systems. However, spatio-temporal variations in the ionospheric plasma affect all these operations, and also low frequency radio astronomy, GNSS and space-borne radar systems. Prediction of ionospheric propagation conditions is therefore critical for ensuring reliable operations. This is facilitated by ground-based observations supporting largely empirical models. However, 70% of the total ionospheric ionization is above the density peak seen from the ground, so topside measurements provide additional fidelity and reveal information on plasma irregularities not evident from the ground. Orbiting sounders also stimulate many plasma phenomena, revealing fundamental gaps in knowledge. Space-based radars (e.g., SAR) are key elements of Earth observation capability, typically operating at C and X-band frequencies. Space-based platforms are essential for studies of the plasma environment of other planets, such as Mars. Characteristics of a digital topside sounder include transmit power of 10-200W. Gallium Nitride (GaN) is the semiconductor of choice for next generation of airborne and space-based communications systems, where high efficiency, high reliability, and superior performance are required in highly compact form factor. In this paper we report on the design, fabrication, and measurement of two GaN based power amplifiers that could be implemented for studies of the topside ionosphere.

The first PA we report is a high efficiency switching power amplifier. Designed and tested for ground-based transmitters, the single module delivered over 35 W of output power with an efficiency of over 79% across the 5 - 50 MHz operating frequency range. A waveform engineered hybrid C-Band PA delivering over 8W was designed and experimentally measured, with a PAE>60%, across the band, with a peak PAE of 68%, and would enable high efficiency satellite downlinks for CubeSat platforms.

The use of advanced semiconductor devices, availability of non-linear device models, innovative circuit design techniques and extensive use of CAD simulators enable the development of next generation instrumentation and communications modules for ground and space-based platforms where size, weight and performance are critical.