A 2.16 GHz Harmonically Terminated 55 % Efficient DC-DC Converter

Ignacio Ramos*, Leonardo Ranzani, Dragan Maksimovic, and Zoya Popovic
University of Colorado, Boulder, CO

One of the main factors limiting the switching frequency in conventional DC-DC converters is the high loss incurred by ferromagnetic components and the non-ideal behavior of lumped elements and transmission lines at higher frequencies. A new approach to designing DC-DC converters based on design techniques used for microwave power amplifiers is presented. The new approach avoids the use of ferromagnetic components and deals directly with impedance matching at high frequencies. Increasing the switching frequency of DC-DC converters not only offers the possibility to significantly decrease the size of the converter, but it could also potentially increase the bandwidth of converters used in high frequency applications such as envelope tracking and reduce EMI concerns since the harmonics of the switching frequency are above operating frequency.

In this talk, a DC-DC converter with a switching frequency of 2.16 GHz is presented. The converter consists on a harmonically terminated PA (class F^{-1}) and a harmonically terminated synchronously driven rectifier (class F^{-1}). In order to avoid magnetic components, shunt opened circuit stubs were used as harmonic traps for appropriate termination of the harmonics, while a short circuited quarter wavelength transmission line was used as the RF choke. The converter is implemented in microstrip in a 30 mil thick Rogers 4350B substrate using two TGF2320-02 GaN HEMTs from TriQuint®. The impedance at the gate of the rectifier is terminated for self-synchronization. The converter exhibits a drain-to-drain efficiency of more than 56 % for an input voltage range of 24V-36V with a fixed output load of 90 Ω. The output power is dependent on the input voltage and it ranges from 3.4 W to 5.8 W.