A 3.5/5.8-GHz Dual-Band Efficiency-Optimized Power Amplifier

Allison Duh, Taylor Barton, and Zoya Popovic
University of Colorado, Boulder, CO 80304

Multi-carrier and carrier aggregation schemes are increasingly used in communications systems to improve data rates and spectral efciency. As a result, there has been signicant recent interest in power ampliers (PAs) able to operate over multiple bands, whether through broadband, multi-band, or frequency-recongurable techniques. In each of these approaches, the output matching network (OMN) presents a design challenge in achieving target output power and efficiency, as the frequency-dependent target loading impedances for the active device tend to exhibit a non-Foster counter-clockwise rotation in the Smith chart.

Recent dual-band PA designs cover a wide swath of frequency bands and technologies using co-design methods, where the PA and matching network are designed in an integrated fashion to reduce insertion loss and mismatch, thus increasing efciency and bandwidth potential. Depending on the frequency band separation and active device characteristics, optimal output impedances in the different bands can be significantly different. One work incorporates dual-band filters, achieving drain efficiencies up to 68% at 0.8 and 1.9 GHz, where the impedances at the two frequencies are $9.9 + j4.8\,\Omega$ and $4 + j2.4\,\Omega$ (X. Fu, et al. IEEE Trans. on Circuits and Systems I, 2014). Another implements switched transformers in an amplifier at 3.1 and 8 GHz with peak drain efficiencies of 34.8 and 12.2% (J. Ko et al., IEEE RFIC Symp. 2017).

This work details a 3.5/5.8-GHz 5-W PA design example that drives a separate load (antenna) in each band. The PA is based on a 6-W Wolfspeed GaN on SiC HEMT. Load-pull simulations at the two frequencies indicate optimal impedances of $14.4 + j2.7\,\Omega$ at 3.5 GHz and $26.8 - j62\,\Omega$ at 5.8 GHz for power-added efficiency. A three-port OMN (Fig. 1) is designed to present, at both bands, these desired fundamental load impedances, and acts as a diplexer in that output power for each signal goes to the appropriate load. The OMN is comprised of four sub-circuits: two perform a real-to-real impedance transformation and two perform a real-to-complex impedance transformation, connected to the transistor through a tee junction. The measured performance of the passive network shows isolation of 30 dB between the bands.

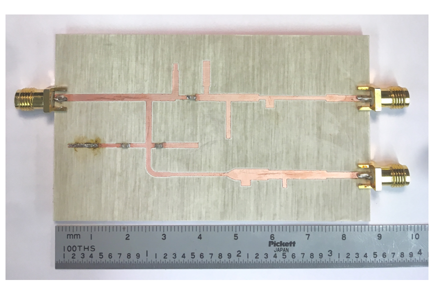

Figure 1: Photo of the fabricated circuit, with upper branch connected to the 3.5, and the lower to the 5.8ǴHz load.