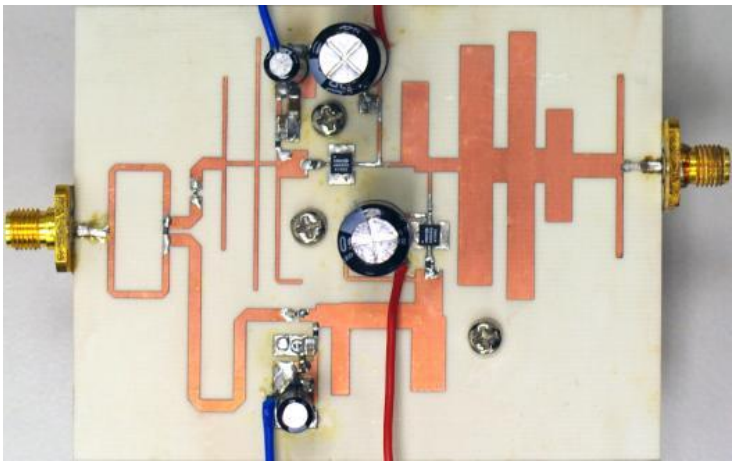
Broadband High-Efficiency Power Amplifier Design for 4G and Beyond

(By research group of Prof. Michael Cheng)

As modern communication system demands higher spectrum efficiency and data rate, new communication standards (e.g. 4G-LTE) using complex modulation scheme (e.g. OFDM) has emerged, leading to transmitting signal with ever-increasing Peak-to-Average Power Ratio (PAPR). Moreover, the co-existence of different standards (e.g. GSM, 3G, 4G-LTE) requires RF transmitters to support signal operating at multiple carrier frequencies (e.g. from 700 MHz to 2.7 GHz). Therefore, wideband operation and efficient amplification of high PAPR signal are essential requirements for base-station deployment. In modern wireless communication, a small improvement in the efficiency of RF PA can help relaxing the requirements on power dissipation and removal of excessive heat, which will lead to increase in system reliability and reduction of installation and running cost. For efficiency enhancement, the Doherty Power Amplifier (DPA) architecture has been regarded as the most popular approach due to its circuit simplicity and moderate linearity. In recent years, Doherty amplifiers have been widely adopted in the construction of advanced base-stations with proper pre-distortion schemes.

Currently, our research team has been investigating new design techniques for the performance enhancement of DPA including operating bandwidth, power efficiency and power utilization of active devices. For instance, a new DPA configuration based

upon of frequency-varying Complex Combining Load has been developed to extend the high efficiency range of the amplifier [1-2]. Theoretical analysis reveals that the adoption of complex combining load can offer a new degree of freedom to boost the efficiency range of DPA without the need of sophisticated architectures (e.g. multi-stage or asymmetrical design). For verification, a 20W, 1.8-2.2 GHz DPA [2] was constructed and characterized (Figure shown below). With WCDMA signal excitation (PAPR of 9.6 dB), an average drain efficiency of 53-58% was obtained at and average output power of 2.5W.



[1] Fang, X.H. ; Cheng, K.-K.M.: "Extension of High-Efficiency Range of Doherty Amplifier by Using Complex Combining Load", IEEE Transactions on Microwave Theory and Techniques, Vol. 62, No. 9, pp. 2038 – 2047, Sept. 2014.

[2] Fang, X.H. ; Cheng, K.-K.M.: "Broadband, Wide Efficiency Range, Doherty Amplifier Design Using Frequency-Varying Complex Combining Load", IEEE International Microwave Symposium, Phoenix, U.S.A., May 2015.