**Development of High-Efficiency Switch-Mode Concurrent Dual-Band RF Power Amplifiers**

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# ***ABSTRACT***

A concurrent dual-band class DF-1 PA was proposed and developed from fundamental theories, design methodology, to actual implementation and finally measurement results. The theoretical analysis showed that, the proposed PA could provide a concurrent-mode (two carriers simultaneously) drain efficiency of 87% at 6dB over drive which was only 5% lower than single-mode operation (one carrier at a time). A concurrent dual-band class B PA (one of linear-type PAs) on the other hand only have a maximum concurrent-mode drain efficiency 62.5%, 16% lower than single-mode case. The output power drop was also reduced from 3dB in linear-type PAs to 1.2dB in proposed PA. The design of the proposed PA however was complicated due to a large number of harmonics and intermodulation components (IMs) to be properly terminated at the output. To reduce the design complexity, the tradeoff between number of harmonics/IMs to be properly terminated and efficiency was discussed based on ADS simulation. It was found out that, the 2nd harmonics/IMs were critical to maintain high efficiency, 3rd harmonics/IMs however has smaller effect on efficiency thus can be neglected (partially) to greatly reduce design complexity with tolerable efficiency degradation. The bias effect was also explored and was suggested that the PA should be bias into triode (defined in chapter 4) or in another word, bias above class A, in order to achieve high efficiency.

The proposed PA was implemented in a push-pull structure which need a balun at both output and input. The design equations of balun was derived in this thesis together with some parameter optimization for minimum imbalance and largest bandwidth. The output balun provides not only differential to single-ended conversion but also a 1:4 impedance transformation. The final PA was fabricated and measured in lab. A drain efficiency of 60% was achieve when operating concurrently at 880MGz and 1.49GHz with less than 0.5dB output power drop compared single-mode operation. The performance was among the best concurrent dual-band PAs. Measurement results together with simulation results show that the proposed PA has the ability to achieve much higher efficiency than linear-type concurrent dual-band PAs with minimum efficiency and output power drop, and thus is capable to make increasingly complicated RF FEM feasible