Circuits and Architectures for 60 GHz Transceivers

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Abstract
mmWave systems offer a path to high speed and highly efficient communication links for consumer devices. The 802.11ad standard specifies speeds up to 7Gbps on 2GHz wide channels. Much progress has been made in circuits and architectures over the last decade. This paper outlines several circuits and an architecture for a mmWave system.

1. Introduction

The continual push for faster wireless systems in consumer devices is driven by the desire for higher performance media streaming, faster sync and better energy efficiency. The next generation of wireless links will be enabled by the wide unlicensed bandwidth available at mmWave frequencies and will provide multi-gigabit per second links.

Applications for mmWave systems include wireless docking, multimedia streaming and point-to-point links. Data rates of up to 7 Gbps on 2 GHz wide channels are specified by the 802.11ad standard. Architectures typically used for wireless systems where the antennas are connected to the radio IC using a coaxial cable may not be optimal for mmWave systems due to the high loss associated with routing a 60 GHz signal over any distance.

This paper outlines several circuits and an architecture for a mmWave system amenable to integration in consumer electronic devices.

2. Circuits at mmWave

Designing circuits for mmWave frequencies is challenging. A design flow that includes accurate device characterization and modeling, device parasitic extraction, accurate reference plane definition, and electro-magnetic (EM) modeling is required.

Designs for 60 GHz circuits have evolved from transmission line based to transformer and lumped LC based designs [1-4].

A transmission line PA designed in 0.18um SiGe is shown in Figure 1, it is a five-stage design with a cascode input stage and 4 common-source stages. This design achieves a wide bandwidth but suffers from large area. A gain of greater than 28dB is achieved from 54 to 65 GHz.

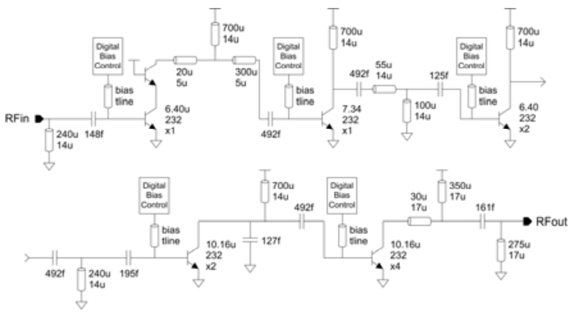

Fig. 1: Transmission line PA schematic

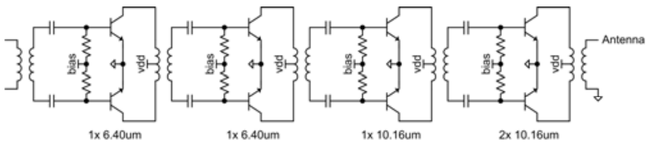

Fig2: Transformer coupled PA schematic

A transformer-based design is shown in Figure 2, it is a four stage common-emitter design and achieves a gain of better than 26dB from 57 to 64 GHz.

A comparison of the two layouts is shown in Figure 3. The transformer based design is much more area efficient and achieves the same performance using a quarter of the area.

3. Architectures for mmWave circuits

Due to the high losses at mmWave frequencies, architectures typically used for lower frequency radios may not be suitable for large consumer electronic devices. A split-IF architecture is suitable and can be implemented in several different ways. In [1] a fixed-IF is used and a low frequency reference is routed over the link to lock a PLL on the front-end.