DESIGN OF CLASS-E RADIO FREQUENCY POWER AMPLIFIER

by

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ABSTRACT

Power amplifiers (PA) are typically the most power-consuming building blocks of RF transceivers. Therefore, the design of a high-efficiency radio frequency power amplifier is the most obvious solution to overcoming the battery lifetime limitation in the portable communication systems. A power amplifier's classes (A, AB, B, C, F, E, etc), and design techniques (Load-pull and large-signal S-parameters techniques) are presented. The design accuracy of class-A power amplifier based on the small-signal S-parameters was investigated, where compression in the power gain was used as an indicator for design accuracy. The effect of drain voltage variation on the power gain compression has been studied in this research.

The class-E amplifier has a maximum theoretical efficiency of 100%. It consists of a single transistor that is driven as a switch and a passive load network. The passive load network is designed to minimize drain (collector) voltage and current waveforms overlapping, which minimize the output power dissipation. Two L-band class-E amplifiers are implemented in section 5.3. One of them is a lumped elements based circuit and the other is a transmission lines based circuit. Both circuits show good performance (60% PAD) over a wide bandwidth (1.0 GHz). In section 5.4, lumped elements and transmission lines based X-band class-E amplifiers are presented. Both circuits show good performance (62% PAD) over wide bandwidth (4.8 GHz).

A new technique to improve the drain efficiency of the class-E amplifier has been proposed. This technique uses two passive networks. One of them is in a series with the shunt capacitor C_S and the other is in a series with the transistor's source terminal. This technique shows improvement in the drain efficiency, which jumps from 62% to 82%.

Last few years have seen an increase in the popularity of the wireless communication systems. As a result, the demand for compact, low-cost, and low power portable (Single-chip) transceivers has increased dramatically. Among the transceiver's building blocks is the power amplifier. Thus, there is a need for a low-cost power amplifier. A 900 MHz CMOS RF PA with one-watt output power and a high power added efficiency (68%) is presented in chapter 6. This PA can be used in the European standard for mobile communications (GSM) handset transmitter.

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