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Enhancing Dynamic Range in an RF Pulse-Width Modulation (PWM) Transmitter by Delta-Sigma Phase Interpolation

Background

RF pulse-width modulation (RFPWM) is the most common method for generating modulated amplitude outputs for switch-mode amplifiers. This is required because switch-mode power amplifiers are digital circuits with only two output states, thus making them incapable of generating intermediate amplitudes. RFPWM is accomplished by varying the duty cycle of the carrier square wave that is input to the power amplifier. Unfortunately, RFPWM has significant dynamic range limitations, as the pulse width required for low amplitude transmission are swallowed and/or distorted.

Invention Description

Research at Arizona State University has led to the development of a delta-sigma phase interpolator designed in 65nm bulk CMOS that extends the dynamic range of an RFPWM transmitter by 29dB. This architecture uses a first-order digital Delta-Sigma modulator to switch between gross phase quantizations, thus generating a highly accurate average phase. Two of these phase outputs are ANDed together in an RFPWM modulator to generate effective amplitudes below the ordinary pulse-swallowing threshold. This novel method allows a standard RFPWM system to be used for modern communication protocols such as LTE, without the need for multilevel or supply tracking techniques. The presented system is capable of generating a 16 quadrature amplitude modulation (QAM) constellation with an error vector magnitude (EVM) of -32.8dB and has a frequency range of 1.2-2.2 GHz. Furthermore, the lack of individual phase interpolator units allows this system to consume an area and power of only 0.019 mm2 and 23 mW respectively.

Potential Applications

- Digital communications

Benefits and Advantages

- Achieves a dynamic range that is over 10x the largest previously reported range

- Generates high QAM constellations
- Suitable for low power and low area applications