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Experimental investigation of phase noise in high-efficiency Class-E amplifiers.

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In mobile and satellite communications the power amplifier (PA) in the transmitting module can consume up to 50% [1] of total system power. Increasing the PA's efficiency is therefore desirable, helping to reduce heat output (consequently relaxing sinking requirements) and conserve battery power in portable units. In response to this need of higher efficiency in generating RF power, class-E and -F switching-mode amplifiers have been extensively investigated up to the micro- and millimeter-wave range [2] yielding very promising results. Typical Class-E power-added efficiencies are of the order of 50% compared to linear (class-A) amplifier efficiencies of 30% at microwave frequencies. This increase in efficiency reduces heat-sinking by about a factor of 2 and increases battery lifetime by about the same factor.

The high efficiency of class E amplifiers results from the use of the active device as a switch, arranging it to have smooth transitions between "on" and "off", so that the duration of the simultaneous presence of both bias current and voltage is minimized, thus reducing power dissipation within the transistor[3].

Because of this highly non-linear operation, given a certain active device with known noise characteristics, it is unclear what the noise performance of the Class-E amplifier will be. Moreover, the relationship between the noise performance and bias conditions for Class-E amplifiers is unknown, while the efficiency and harmonic content of the amplifier is critically dependent on these bias conditions.

We will present for the first time some of the tradeoffs between noise performance (both wideband and close-to-carrier) and efficiency in Class E amplifiers. A class-E amplifier has been built with a Fujitsu FLK027WG GaAs MESFET capable of 250mW of output power. Preliminary measurements of the 4.6GHz class-E amplifier indicate a power-added efficiency of about 42% at 250mW. At full power, this particular class-E circuit is operating in a *sub-optimal* class-E mode. A more efficient mode can be obtained by operating at a lower output power level. These measurements are still in progress, as are measurements of the phase noise of the class-E amplifier.

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