Transmission Line Effects in Carrier Synchronized Direct Antenna Modulation Transmitters

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Switched, time varying antennas have been proposed to overcome the bandwidth limitations of electrically small transmitters using a method often referred as direct antenna modulation (DAM). While the DAM technique can be applied to a variety of modulation types, we study an on-off keyed (OOK) DAM system in this paper. Several configurations of OOK-DAM transmitters have been proposed, but our recent analysis concluded that in order to derive a benefit in the bit error rate (BER) of the DAM-OOK system, the critical requirement is that antenna must store charge (and near field energy) during the 'off' state rather than releasing it back to the feedline and transmitter. The simplest configuration that meets this condition is a series single-pole, single-throw switch connected at the feed terminal of an electrically small antenna where the switch is open or closed precisely at the instant when the voltage across the antenna's terminals is maximum.

In principle, this configuration allows for data transmission at symbol rates far beyond the antenna's conventional time-invariant bandwidth. However, there are practical limitations to this transmission rate. While it has been recognized that the performance of this carrier synchronized DAM-OOK system is limited by the characteristics of the available switches, there has been no detailed analysis of how small transmission line delays in the switching path impact the DAM-OOK system. In his work, analytical and electromagnetic-circuit co-simulation models are used to study the effects of a transmission line length connected between the antenna and the switch. The analysis demonstrates that even electrically short transmission line length causes significant ringing at its loaded anti-resonant frequency. Electrically longer lines are expected to have even more severe effects and therefore limit the performance of the system at high frequency.