Impact of Antenna Q-factor on Power Handling in Direct Antenna Modulation Transmitters

K. R. Schab, D. Huang, and J. J. Adams*
Department of Electrical and Computer Engineering, Antennas and Electromagnetics Laboratory, North Carolina State University, Raleigh, NC, USA

Efficient, electrically small antennas are well-known to have high Q-factor (Q) and thus, narrow bandwidth. Therefore, electrically small antennas act as undesirable narrowband filters, passing only low throughput data streams. Recently, a direct antenna modulation (DAM) technique using switched, time-varying matching networks (Galejs, 1963) has been rediscovered (Xu, 2006, Salehi 2013, Janaswamy 2014) as a viable method for transmitting broadband signals even when the antenna's steady-state bandwidth is narrow. This DAM technique relies on fast switches placed on or near the antenna aperture to store and release energy at appropriate times during the carrier's cycle. In theory, properly synchronized DAM enables nearly instantaneous transitions between symbols of certain modulation schemes (*e.g.,* PSK, OOK) and thus data rates far beyond what the antenna's conventional bandwidth would allow. However, in practice there are significant practical challenges in implementing DAM in a transmitter.

In this work, we report on the impact of the antenna's Q-factor on the power handling of the transmitter. Using transient circuit analysis as well as laboratory and field measurements, we demonstrate that the Q-factor effectively amplifies the voltages that appear across the switch terminals, even in configurations where the switch is placed outside of the resonant circuit. This leads to several effects consequential to practical implementation of DAM. These include a significantly reduced maximum steady-state power handling capability and an asymmetry in the break-down behavior of the transmitter, depending on whether the carrier is switched during the positive or negative half of the carrier cycle. In the presentation, we will compare analytical predictions with measured results using several commercial switches as well as mitigation strategies and an outlook for future progress in this area.