Wideband Direct Antenna Modulation Using High-*Q* Antennas

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Wireless communication techniques have been broadly developed during the past decades due to their extensive applications. One required characteristic of most wireless systems is a wide transmitting bandwidth through a small-size antenna. Although there have been lots of studies on different techniques to broaden the bandwidth of the small antennas, the antenna bandwidth is strictly ruled by the fundamental physical limit. It is well-understood that in linear time-invariant (LTI) structures, antenna bandwidth is in contradiction with the size and hence, small-size antennas suffer from narrow bandwidth. This problem becomes significant when a high-rate data-transmission is required along with a very small-size antenna.

We present an efficient technique to realize a high-rate binary FSK direct modulation by using the transient properties of high-*Q* antennas. We show that if the natural resonance of a narrowband resonant-type antenna is switched at a high rate, the radiating signal follows the variation of resonant frequency and provides a high-rate data-transmission regardless of the narrowband characteristics of the antenna. The bit-rate in this method is dictated by the switching speed rather than the impedance bandwidth. Furthermore, if the switching frequency is properly chosen such that the stored energy in the near-zone is not disturbed, instantaneous bandwidth of the antenna will not limit the data-rate as well. To demonstrate this idea, we utilize a high-*Q* miniaturized antenna loaded by switched capacitors as tuning elements. We show that if the tuning capacitors are switched between different levels, the frequency of the radiating fields will be modulated. If there is a high isolation between the two resonances, the frequency at which the fields resonate, changes according to the switching signal which is coded by a sequence of digital data. Thus, an FSK signal can be generated directly by the antenna. The maximum realized bit-rate is therefore a function of switching rate rather than impedance bandwidth of the antenna. Experimental results are presented in order to validate the simulations.