Design of Matching Network for HF Vehicular Antennas

Matthew Arendall*[(1)], Maxim Ignatenko[(1)], Saurabh Sanghai[(1)], and Dejan S. Filipovic[(1)]
(1) Department of Electrical, Computer, and Energy Engineering
University of Colorado, Boulder, CO 80309-0425

High frequency (HF) communications are regaining interest in large part due to their robustness for establishing long haul (beyond the line of sight) links over 2 to 30 MHz frequency range. However, the conventional 3 kHz channel bandwidths are not sufficient for the amount of information that needs to be communicated, so hardware and software solutions that enable wider bandwidths (24 kHz or more) are being sought. The bandwidth requirements are particularly challenging for antennas aimed to be integrated on vehicles where small physical size (relative to the vehicles' profile) is needed. The small physical size also leads to the small electrical size, especially at the lower portion of the HF band, where the features of electrically small antennas make their development extremely difficult. In that light, tunable matching networks able to support wider bandwidths with hopping RF carriers at HF at the reduced loss are also desired.

This paper considers some theoretical and practical aspects regarding the design and development of matching networks for near-vertical incidence (NVIS) vehicular antennas operating over 2-10 MHz range. To baseline the engineering of matching networks, the conventional L-networks with two lump elements are considered first. Analytical solution for this case is known and is used to service as a reference point for the future design steps. It is seen that this solution shows a range of element values needed for acceptable matching across the NVIS band. The finite quality factor of utilized elements is taken into account next. Careful sensitivity studies of the matching circuit to elements tolerances and their impact on total antenna efficiency are conducted. This was essential part in assessing their impact on the overall antenna performance when placed on a vehicle. Based on this analysis, tolerance class and series of practical inductances and capacities are chosen. The range of tunable impedances with a given set elements is also considered. Finally, matching networks for a class of different prototypes of NVIS antennas are built and matched impedances are measured. Impact of the matching network losses on the achievable bandwidth as well as efficiency is determined.