8×4 Long Slot Array for Far-Field Wireless Power Transfer Applications

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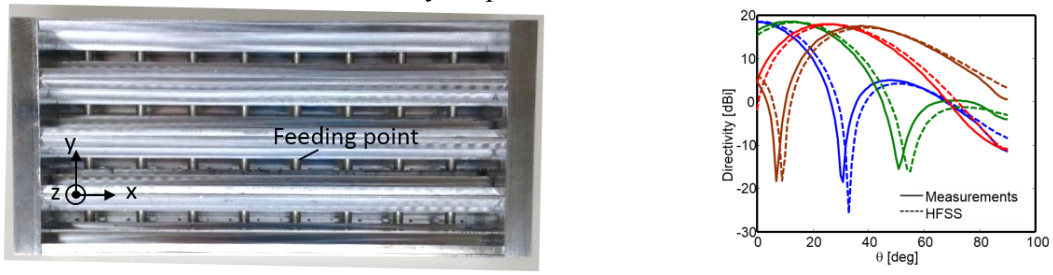
Far-field wireless power transfer (WPT) systems require electromagnetic interaction between a transmitting and a receiving unit located in the far-field zone. The receiving unit is generally a mobile electronic device. The transmitting unit thus needs to locate and transfer energy efficiently to the receiving unit. Retro-directive arrays, or generally phased arrays are possible candidates for the transmitting unit (X. Wang et al., IEEE AWPL, 13, 919 - 922, 2014). The main requirements for such arrays are a wide field of view to cover an area of interest, low profile for ease integration into existing infrastructure, and high efficiency. Arrays of resonant elements are commonly used for far-field WPT systems, but have limitations in terms of field of view and efficiency (M. Ettorre et al., IEEE TAP, 65, 2975 - 2982, 2017). Here we investigate the advantages offered by an array of long slots for far-field WPT systems. Arrays of long slots are well-known for their wide scanning capability (up to 60° in elevation) (F. Foglia Manzillo et al., IEEE TAP, 63, 3291 - 3297, 2015). These antennas are based on non-resonant slots fed by a parallel plate waveguide (PPW) beam-forming network. An equivalent line source is then required for their excitation. The line source is generally implemented as a quasi-optical system with a cluster of feeds in the focal plane. The feeds and/or the full array are then mechanically moved for beam steering, precluding rapid steering of the antenna pattern. Here, we propose a novel feeding mechanism. It employs wide-band coaxial probe feeds directly connected to the radiating slots by a PPW transition. Such a system avoids using a PPW beam-forming network or a quasi-optical system. An 8×4 antenna array is designed in the ISM band around 5.8 GHz. A prototype array is realized in aluminum using standard milling processes, as shown in Fig.1 (a). Measurement results validate a field of view of ±45° in elevation, as shown in Fig.1 (b) along the xz-plane. The proposed solution may be a possible candidate for retrodirective far-field WPT systems. Further, it could be directly connected to electronic circuitry performing time-reversal functions in order to extend the array's operation to near-field scenarios.



(a) (b)

Figure 1. 8×4 Array of long slots. (a) Front view of the prototype. The coaxial-probe transition is labeled as a feeding point. (b) Directivity in the xz-plane for scanning at θ=0°, 15° ,30° and 45° at 5.8 GHz. Simulation results from Ansys HFSS are shown for comparison.