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Performance Analysis of Near-Field Antennas for RFID Applications

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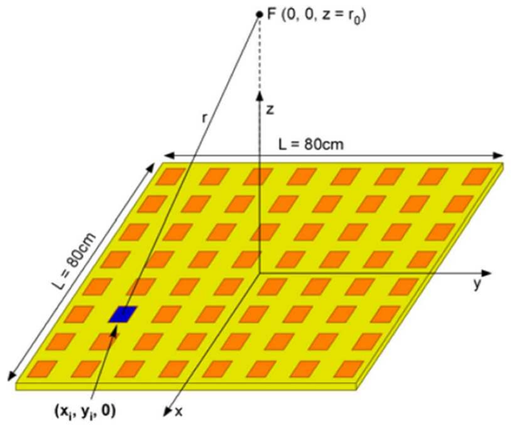
Abstract

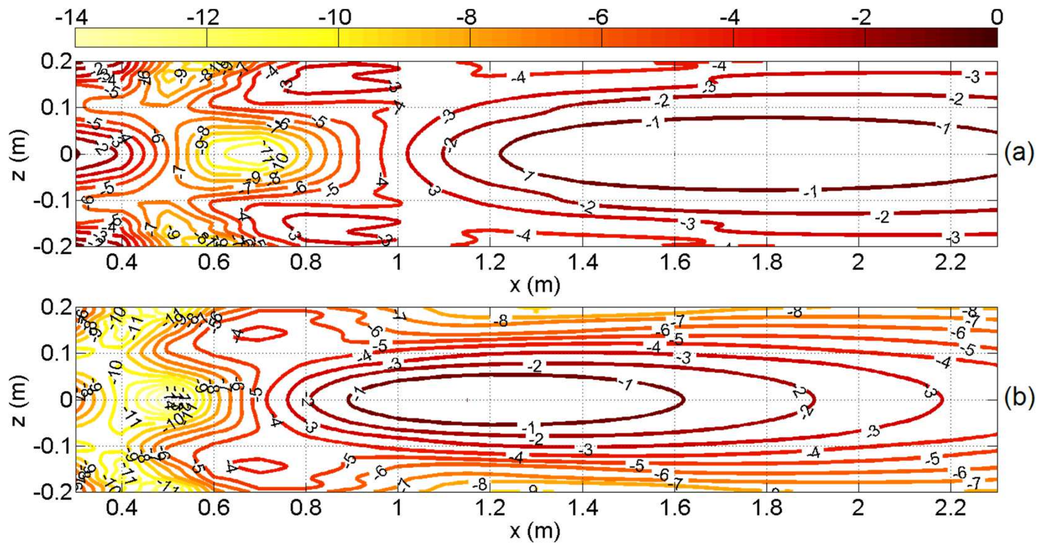
In the last decades, the passive Radio Frequency IDentification (RFID) technology allows the growth of new item level tagging applications in retailing and manufacturing industries. For those applications in which reader antenna and tag are close each other, the near-field features of the electromagnetic field can be exploited to improve system performance. In this framework, two different topologies of near-field antennas operating in the UHF band are designed and characterized: a 8x8 near-field focused microstrip array (2.4 GHz) and a CPW travelling wave antenna (865-928 MHz).

8x8 Near-Field Focused Microstrip Array (2.4 GHz)

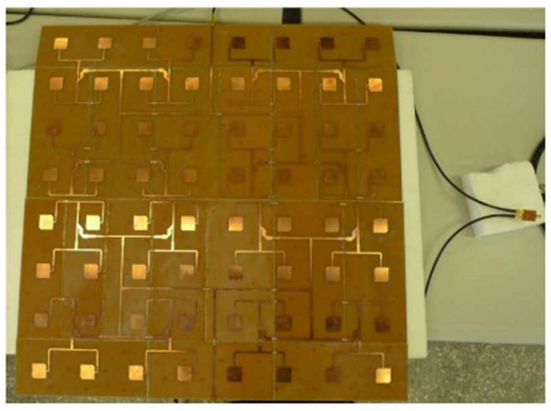
A Near-Field (NF) focused array can be used to maximize the electric field amplitude in a limited-size spot around a given focal point located nearby the antenna aperture (in the antenna near-field region). Such feature could be useful to avoid the false-positives issues (undesired readings outside the volume of interest), to limit interferences with other readers, to better satisfy the EIRP regulation in the far-field region.



- A 8x8 NF focused circular-polarized microstrip array for fixed readers has been designed to operate in the 2.4 GHz ISM band (2.4-2.48 GHz) by employing the Ansys Designer software. The focal distance has been set to r_0=*1.5 m.*
- To maximize the electric field in the desired volume close to the antenna surface, the feeding currents of each array element have to be properly chosen to compensate their distance from the focal point.

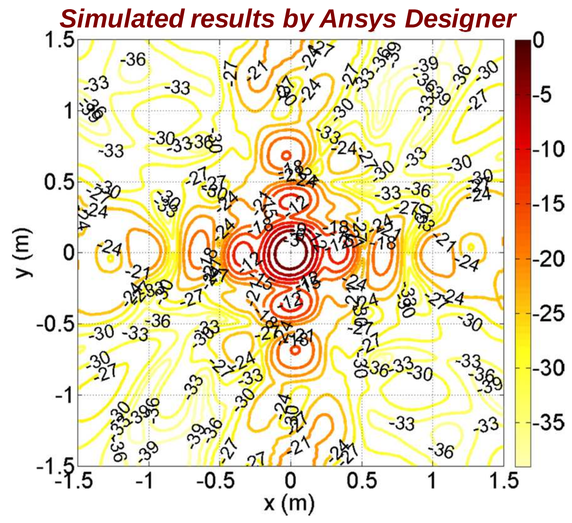


Simulated (Ansys Designer results) normalized power density (dB) in a 0.4x1.7 m² area on the plane (y=0) orthogonal to the antenna aperture: (a) 8x8 uniform phase array, (b) 8x8 near-field focused array with a focal distance r_0=1.5 m.

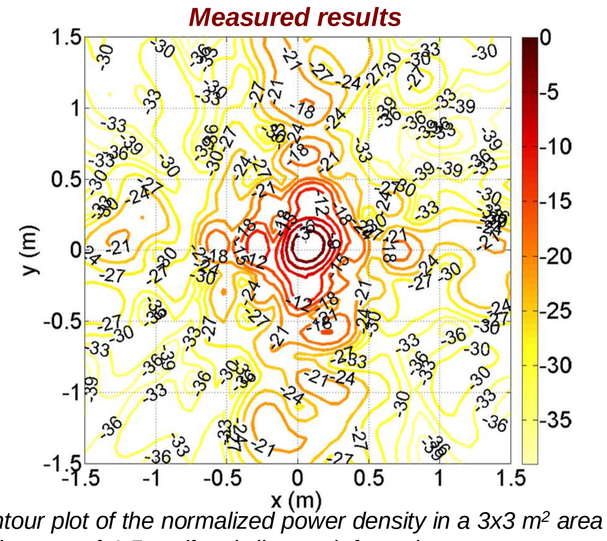


A prototype of the 8x8 NF focused microstrip array (80x80 cm²).

Simulated results by Ansys Designer



Measured results

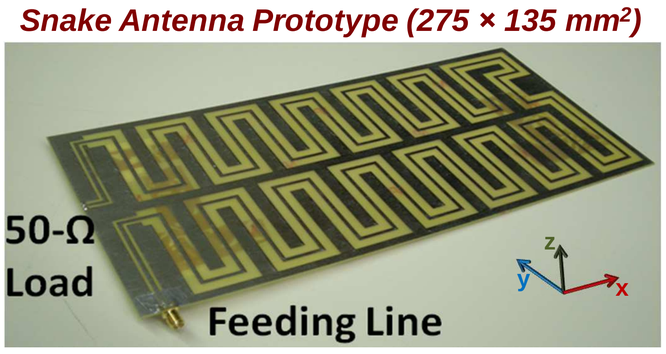


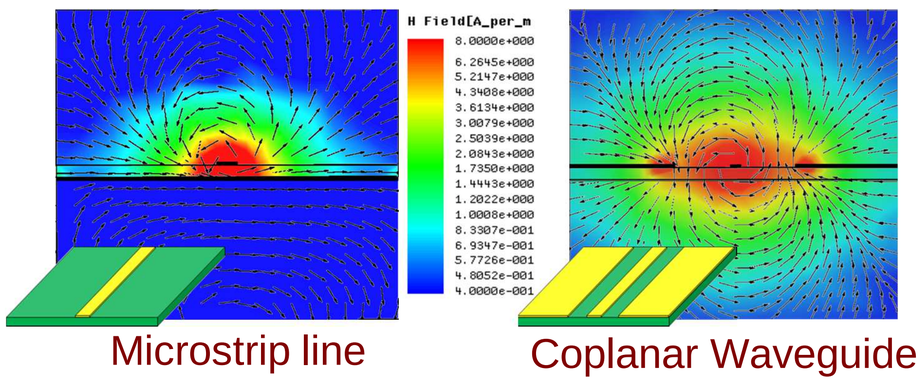
Contour plot of the normalized power density in a 3x3 m² area at a distance of 1.5 m (focal distance) from the antenna aperture (8x8 NF focused array with a focal distance r_0=1.5m)

CPW Travelling Wave Antenna (UHF Band)

An NF UHF-RFID reader antenna operating in the 865-928 MHz frequency band has been designed. Such an antenna is able to limit the electromagnetic field in the antenna near-field region with low far-field radiation, in order to detect tags up to 10 cm from the antenna surface, and to avoid the false-positives issues.

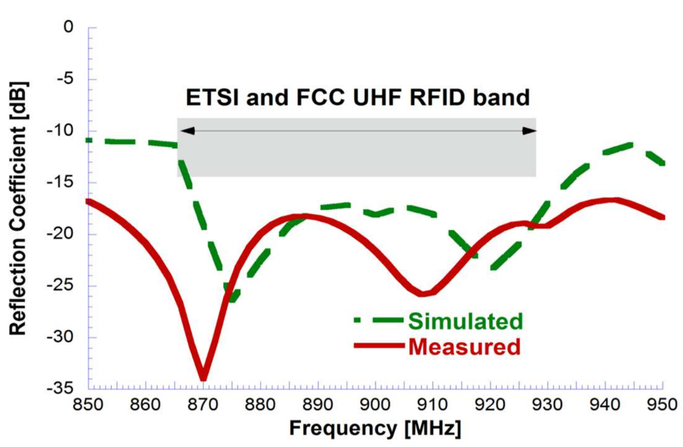
Snake Antenna Prototype (275 × 135 mm²)



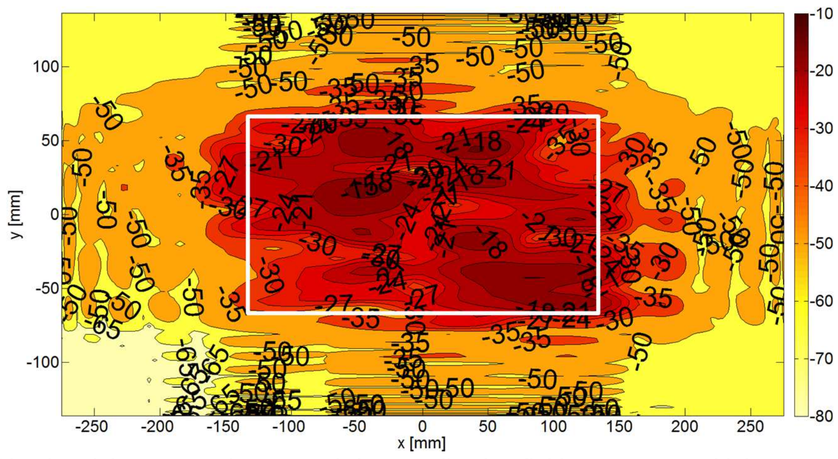


Magnetic field intensity and vector distribution on a plane transverse to the straight line. Differently from the microstrip line, the higher the CPW line characteristic impedance, the slower is the field decay.

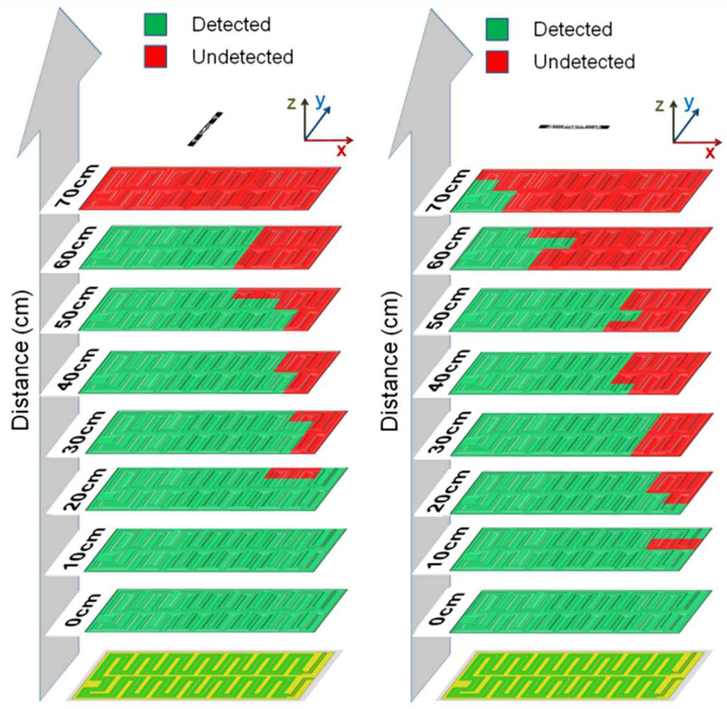
- The CPW line ends on a matched load (50-Ω), to avoid a standing wave (non-uniform) field pattern on the antenna surface
- The meander layout (giving the name Snake antenna) has been adopted to get an electromagnetic field distribution as uniform as possible above the antenna surface
- The meanders design allows to radiate both field components along x and y directions



Reflection coefficient of the *Snake Antenna*



Simulated (Ansys Designer results) normalized H-field components (dB) on a xy-plane (275 × 135 mm²) at a distance of 1 cm from the Snake Antenna surface.



Detection tests by varying the distance of the tag from the antenna surface, when the long-range tag (ALN 9640 Squiggle Inlay, Alien Technology) is aligned to the (a) *y*-axis and the (b) *x*-axis (input power equal to 23 dBm).