Lens-included Horn Antenna to Flatten Aperture Phase and Amplitude Distribution

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Uniform phase and amplitude distributions over the horn aperture maximizes the aperture efficiency and directivity of the horn antenna (E. Lier and A. Kishk, IEEE Trans. Antennas Propag., vol. 53, no. 1, pp. 125138, Jan. 2005). Applying a metamaterial-based gradient index (GRIN) lens to the horn aperture is one well-known solution for preparing a planar wave at the aperture, but with this method the wave amplitude is focused (M. Q. Qi et al., Scientific Reports, vol. 5, p. 9113, Mar. 2015) because the GRIN lens has maximum refractive index in its center to flatten the wave's phase over the horn aperture. Therefore, it is not possible to create uniform amplitude and phase simultaneously at the aperture of the horn antenna using GRIN lenses only. Quite Recently, a uniform amplitude and phase distribution has been achieved by adding a baffle inside the horn antenna (Z. Tao, W. X. Jiang, H. F. Ma, and T. J. Cui, IEEE Trans. Antennas Propag, vol. 66, no. 1, pp. 1622, Jan. 2018), creating hybrid modes and adding GRIN lenses at the aperture. The uniform amplitude distribution was achieved at the expense complexity which might become more challenging at higher frequencies.

Here, we propose a GRIN lens with minimum refractive index in the center to defocus the wave amplitude and make uniform amplitude. We do not, however, place the lens at the aperture; we locate the lens inside the horn. Therefore, the phase distribution will volve between the lens and the aperture and it will be uniform on the aperture inside the horn via accurate lens placement. The center frequency is selected to be 10 GHz to prove the concept making use of an X-band horn antenna. The GRIN lens is designed by drilling hole arrays in Teflon(PTFE), which makes fabrication easy and scalable to higher frequencies. Details of the design procedure and results of the proposed structure will be discussed and presented at the symposium.