Air-Filled Substrate-Integrated-Waveguide Cavity-Backed Slot Antenna with Optical Feeding

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A novel air-filled substrate-integrated-waveguide (AFSIW) cavity-backed slot antenna is proposed, which operates within the 3.30-3.70 GHz frequency band, covering several LTE bands, and whose transmit power is supplied by a single optical fiber. In the adopted optical feeding scheme, a laser with a wavelength equal to 0.85 µm is directly modulated by the signal to be transmitted wirelessly. The signal power is contained within the 3.30-3.70 GHz frequency band. The resulting optical signal is guided by a multi-mode optical fiber toward a high-speed photodetector, integrated on the AFSIW antenna. Consequently, the proposed antenna acts as the down-link remote-radio-head (RRH) in an analog radio-over-fiber (RoF) [1] or fiber-to-the-antenna (FTTA) [2] scheme.

A low-profile AFSIW antenna topology [3] is adopted, which leverages the use of multiple resonators and an air substrate to achieve a wide impedance bandwidth and a high radiation efficiency. The topology is optimized to provide good impedance matching w.r.t. 50 Ω across the entire frequency band of interest. The antenna exhibits directive radiation in a single hemisphere with linear polarization, and a good front-to-back ratio of over 10 dB. The high antenna/platform isolation offered by the SIW cavity allows to integrate the optical receiver hardware on the ground plane printed circuit board, resulting in a compact RRH. The optical receiver consists of a photodetector, connected to the AFSIW antenna via a passive impedance matching network, which maximizes power transfer from the photodetector to the antenna over the entire bandwidth. Omitting electrical (transimpedance) amplifiers limits the transmitted signal power, but when considering sufficiently small propagation cells, this is without consequence [4].

The proposed RRH was constructed and validated, confirming the high performance predicted during design. The measured peak far-field gain (referenced to the modulation input of the laser) amounts to 0.50 dBi, and remains stable (within 3 dB) across the entire frequency band of interest. The normalized far-field gain patterns measured in the E- and H-planes at 3.50 GHz are depicted in Figure 1.

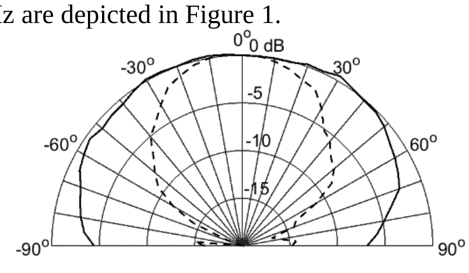

Figure 1. Normalized far-field gain patterns measured in the E-plane (solid) and H-plane (dashed) at 3.50 GHz.

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[2] P. McClusky and J. L. Schroeder, "Fiber-to-the-antenna: Benefits and protection requirements," *Intelec 2012*, Scottsdale, AZ, 2012, pp. 1-6, doi: 10.1109/INTLEC.2012.6374502.
[3] Q. Van den Brande, S. Lemey, J. Vanfleteren, and H. Rogier, "Highly-Efficient Impulse-Radio Ultra-Wideband Cavity-Backed Slot Antenna in Stacked Air-Filled Substrate-Integrated-Waveguide Technology," in *IEEE Transactions on Antennas and Propagation*, 2017, 9 pages, submitted, 2017.
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