A Tunable S-band Frequency Selective Surface for Low Power Sensing Applications in Inaccessible Areas

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Low power, remote wireless sensing is a field of increasing interest and growth within the electromagnetics community. Developments in this area are motivated by a desire and in some instances a need for a hands-off sensing approach. In these cases direct user interaction with a given sensor system in the weeks or months following its deployment may be undesirable, unsafe, or impossible. Under such circumstances, achieving a low total power consumption for the composite system is critical to its longevity and effectiveness.

Low power sensors are constantly in development by many companies for a wide range of applications. The use case for this system in particular is to detect airborne toxins in a safe and reliable way without the need for proximal human interaction. The proposed solution has three components.

The first and second components of the system are a nanofiber sensor used for toxin detection and a specialized circuit for low power analog to digital conversion and sensor data processing. During typical operation, the system draws minimal power from coin cell batteries, allowing for continual operation for at least several weeks.

The third component of this system is the low power wireless communication interface. To achieve this low power consumption, one approach is to avoid having the sensor system broadcast altogether, instead letting a receiver with few power requirement restrictions remotely interrogate the sensor though RF transmission and backscatter analysis. Systems operating under this paradigm use low power electronics to make changes to their reflection properties which may be detected in turn by RADAR systems (M. G. Bray, A. E. Kovalev, Z. Bayraktar, D. H. Werner, T. S. Mayer, *Antennas and Propagation Society International Symposium*, 9-15 June 2007). This is the elected approach for this system, which relies on very low power varactor diodes to configure a frequency selective surface (J. P. Turpin, J. A. Bossard, K. L. Morgan, D. H. Werner, and P. L. Werner, *International Journal of Antennas and Propagation*, vol. 2014, Article ID 429837). By altering the voltage bias on the varactor, the resonant characteristics of the FSS can be changed, leading to a tunable reflection band. Sensor information can be encoded in the center frequency of the reflection band such that remote systems can recover this sensor information simply by examining the return spectra of the frequency selective surface. For this system, different center frequencies will correspond with different concentrations of airborne toxins detected by the sensor card.