Low Cost and High Performance Quasi-Optical Filter for Phased Arrays

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High performance quasi-optical grid or Frequency Selective Surface (FSS) filters are often required in the advanced sensor, radar, and communication systems for (1) the spatial filtering of millimeter and sub-millimeter-wave remote sensing (R. Dickie, R. Cahill, H. Gamble, and V. Fusco, IEEE Trans., AP-53,6, 1904-1911,2005), (2) the spatial image rejection of J-band radar (M. Moallem and K. Sarabandi, IEEE Int. AP Symp., Chicago, IL 2012), (3) preventing interference between a phased array and other antennas on the same platform (S. Monni, A. Neto, G. Gerini, F. Nennie, and A. Tijhuis, IEEE AWPL, 8, 220-223, 2009), and many other applications (T.K. Wu, Frequency Selective Surfaces and Grid Arrays, Wiley, 1995).

In modern multi-function phased array antenna systems especially employed for the above stated applications, these low cost, low volume, and low mass quasi-optical filters can be easily mounted on top of the radiating aperture of the array antenna. It is extremely superior and cost saving compared to the alternative approach of adding the heavy and bulky circuit-type RF filter to each individual array element. In this paper, a single thin screen FSS with the printed rectangular (or square) shaped split-ring resonator elements will be demonstrated to exhibit the same sharp-transition between the passband (221-223 GHz) and stopband (206-208 GHz) but with much better performance than the FSS element of the above mentioned 2nd reference.

It should be noted that the FSS element described in this paper is very similar to the split-ring resonator meta-surface structure used for tuning and biosensor applications (C.L. Holloway, E. Kuester, J. Gordon, J. O'Hara, J. Booth, and D. Smith, IEEE AP Magazine, 54, 10-35, 2012.) However, in this paper, a different but more efficient quasi-static analysis model will be shown to provide accurate (filter) performance results as compared to Holloway's measured data. More detail will be presented to validate the analysis model and the (sharp-transition) high performance quasi-optical (or FSS) filters.