Improved Bandwidth Performance of Large Ka Band Slot Arrays for Space Based Interferometric Systems

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Abstract
This paper reports on our investigations on large Ka band slot arrays for space based interferometric systems. Prior work has shown that manufacturing tolerances pose challenges to achieving the required performance of arrays made up of resonant elements. Array architectures that provide improved bandwidth for return loss and good pattern performance, and hence less sensitivity to manufacturing tolerance, are presented.

1. Introduction
Glacier and land ice surface topography interferometer (GLISTIN) was proposed for topographic mapping of ice sheets and glaciers [1]. Fig. 1 shows the GLISTIN instrument consisting of two 4m x 1m Ka band digital beam formed arrays.

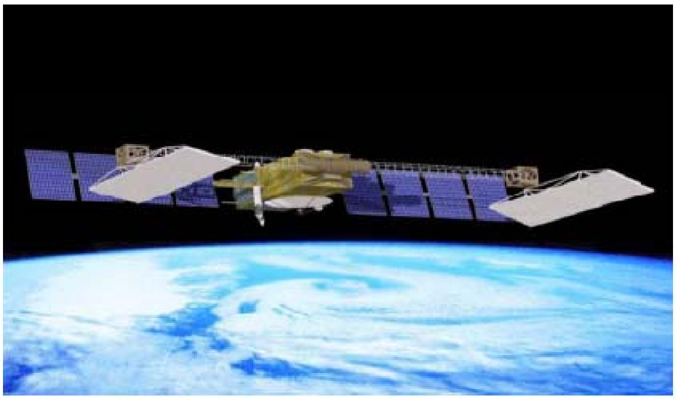

Fig. 1 GLISTIN interferometric configuration

For technology demonstration, a 1m x 1m array, which is one of the four panels that make up the 4m x 1m GLISTIN array was built and tested [2]. The 1m x 1m array development was successful in meeting the primary objective of aligning the beams of sixteen sticks, each containing 160x10 radiating elements to make one digital beam. Fig. 2 shows the back of the demonstration array. The demonstration array was fabricated using the dip-brazing process with a manufacturing tolerance of 1 mil (25 μ). The tolerance level achievable was rather high and it resulted in degraded antenna performance.

Fig. 2 Demonstration array with 16 receive sticks and one transmit stick

2. Development of better array architectures
The array architecture with alternating offsets in adjacent waveguides employed by Svensson et al., provides greater impedance bandwidth [3]. If such an architecture is used as a sub-array in a large array, impedance bandwidth limitation from mutual coupling effects is reduced substantially [4]. However, the use of a single sub-array shown in Fig. 3 results

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in grating lobes in the order of 15 to 18 dB below the mainlobe level in the diagonal planes, at $\phi=45^{o}$ and 135^{o} and $\theta\sim70^{o}$.

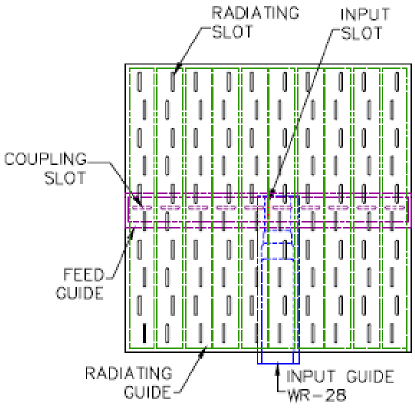

Fig. 3 Geometry of a sub-array with alternating offsets in adjacent waveguides

This work has investigated methods of improving the performance of large slot arrays. First, we choose adjacent sub-arrays in the magnetic field or H-plane such that the radiating slots of the two sub-arrays are symmetric with respect to a line separating the two sub-arrays. The two sub-arrays are excited with the same amplitude but with 180^{o} phase difference. Such an arrangement of sub-arrays results in nearly 10 dB reduction in the grating lobe levels, thus making it acceptable. The impedance bandwidth is further improved by the use of two inductive irises near the input waveguide port. The genetic algorithm along with mode matching technique has been employed to adjust the four parameters of a two-section iris-matching transformer to produce better than 12 dB return loss over 6% bandwidth, thereby making it less sensitive to manufacturing tolerances. Further optimization of the antenna performance is accomplished by using the genetic algorithm in conjunction with a full wave method-of-moments (MoM) solution to the pertinent integral equations for an infinite array of sub-arrays. The unit cell in the infinite array MoM problem consists of two 10x10 sub-arrays in the H-plane with symmetric radiating slots. Some variations of Fig. 3 have been considered in the sub-array architecture. Our MoM analysis results on the return loss and pattern performance of optimized designs will be presented at the symposium.

3. Acknowledgment

The author is grateful to Dan Hoppe of Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA for the mode matching computer programs.

4. References

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