Dual Band Interleaved Base Station Phased Array Antenna With Optimized Cross-Dipole and EBG/AMC Structure

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***Abstract*— In this work, a new base station antenna is proposed. Two separate frequency bands with separate radiating elements are used in each band. The frequency band separation ratio is about 1.3:1. These elements are arranged with different spacing (wider spacing for the lower frequency band, and narrower spacing for the higher frequency band). Isolation between bands inherently exists in this approach. This avoids the grating lobe effect, and mitigates the beam narrowing (dispersion) seen with fixed element spacing covering the whole wide bandwidth. A new low-profile cross dipole is designed, which is integrated in the array with an EBG/AMC structure for reducing the size of low band elements and decreasing coupling at high band.**

I. Introduction

In an array of elements with fixed locations, the characteristics of the radiated pattern vary with frequency (Fig. 1): the main beam narrows and grating lobes appear as the frequency increases. If a wide bandwidth element is used, the beam narrowing is excessive at the high band end. In addition, isolation between array input ports must be achieved with a diplexer, which introduces loss as well as expense and complexity. To resolve this issue, using separate elements in base station array antenna for each of two bands, with independent spacing (Fig. 2) has been often used. However, this technique has been usually used for bands which are multiples of one another [1], (*i.e.* 900MHz, 2100MHz bands co-existing on the same conductive reflector).

In the proposed approach, the frequency bands are not near multiple factors of one another. In fact, the 1800MHz, 2100MHz low bands and the 2690MHz high band are relatively close to one another. Different element spacings were chosen for low band (*e.g.* 85mm) and high band (*e.g.* 63mm), resulting in no co-located elements, and asymmetry in the array. This gave independent and electrically optimal element spacing in each band. Choosing separate elements takes advantage of the isolation inherent between the elements to increase the isolation between bands at the antenna input ports, reducing filtering requirements. The main challenge with this approach is to limit the effects of the closely-spaced elements on adjacent elements. This includes mutual coupling as well as perturbation of the individual element patterns. This approach is useful for relatively closely spaced frequency bands in the same antenna, somewhere about 1.3:1.

Based on [2, 3], a new printed cross-dipole antenna element has been designed with low profile. We have also introduced an Artificial Magnetic Conductor (AMC) to reduce the size of the low band element. The AMC structure is made of conductive patch in a printed circuit board. This structure presents an Electromagnetic Band Gap (EBG) behavior in the high band.

In the paper, 1710-2170MHz and 2490MHz-2690MHz will be, respectively, called the low band and high band.

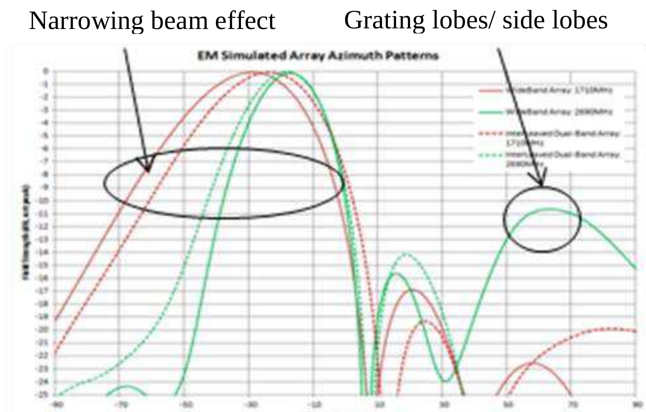
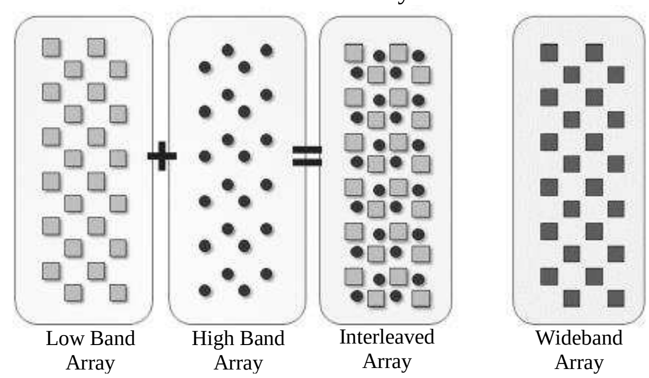
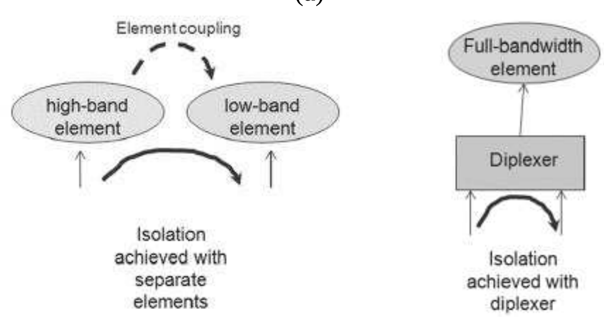


Fig. 1 Undesired dispersion effect in radiation patterns of wideband array



(a)



(b)

Fig. 2 Interleaved array of separate elements is compared to an array of full wide band element (a) architecture, (b) isolation

II. ARRAY DESIGN AND NUMERICAL RESULTS

The proposed array has 8 ports: each band has ±45° polarization ports and two beams ports (for dual sector base stations). Top and side views of the array are shown in Figs. 3 and 4, respectively. Azimuth beam forming is obtained with a wideband butler matrix and elevation beam tilting is controlled with phase shifters.

As shown in Fig. 4, two cross-dipoles with low profile are used for low band and high band. These antennas were optimized with return losses and cross-polarization coupling less than -15dB. To reduce further the size of the low band cross-dipole, an EBG/AMC structure is placed around it. The EBG/AMC structure is designed such that the AMC behaviour is observed in the low band (Fig.5) and the EBG behaviour is observed in the hig h band (Fig. 6).

The full-wave simulated co-pol radiation patterns of the full array, for two sectors and one elevation downtilt, are presented in Fig. 7, showing fairly low dispersion.

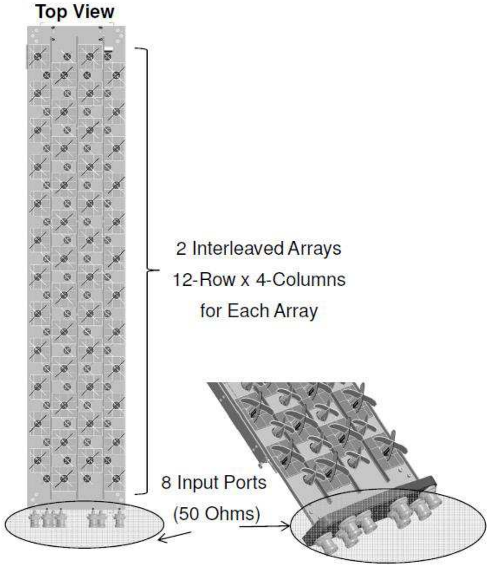


Fig. 3 Top view of the 8-port interleaved array

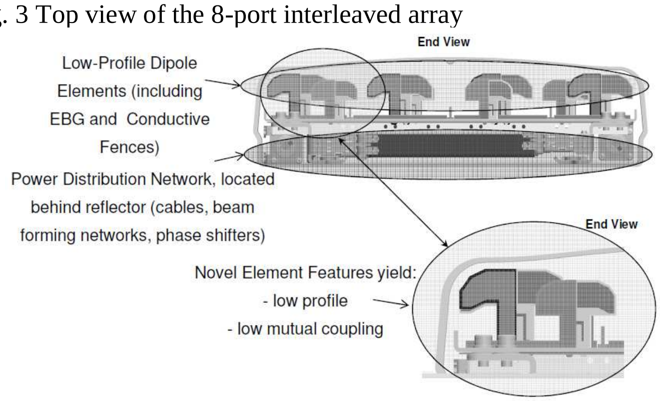


Fig. 4 End view of interleaved array showing optimized low profile cross dipoles

III. CONCLUSION

A new 8-port interleaved base station antenna is proposed using low-profile cross dipole and EBG/AMC structure. More details on the design and performance of the array will be presented during the conference.

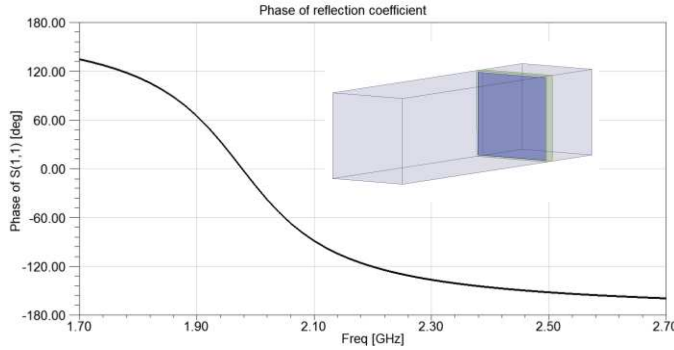


Fig. 5 Phase of reflection coefficient of the AMC structure analyzed using Floquet boundary conditions

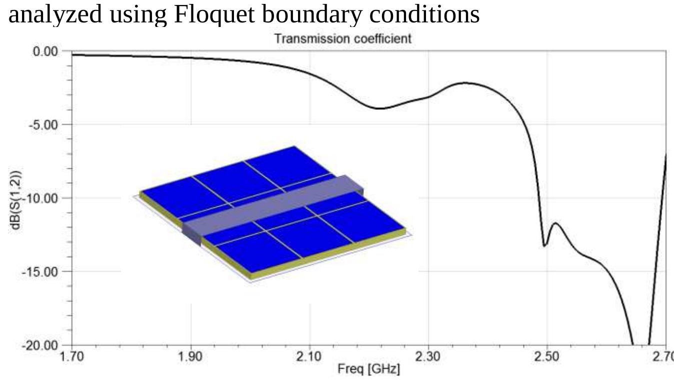


Fig. 6 Stop band characteristic of the EBG structure analyzed using suspended line

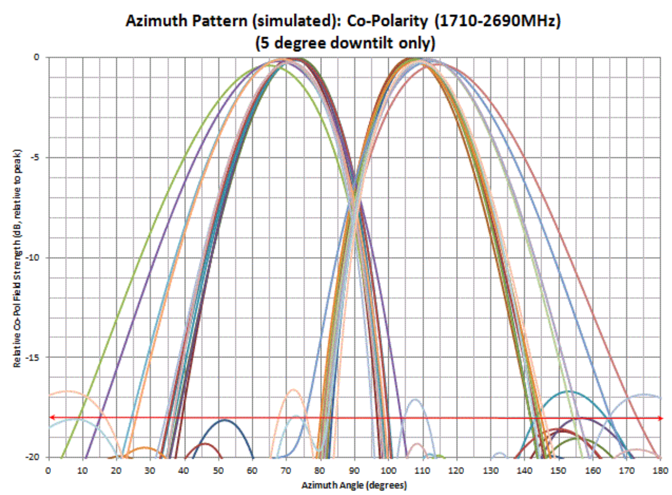


Fig. 7 Azimuth radiation patterns for co-pol in the entire operation band of the array

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