subarray 7 is shown separated from the array 5. In embodiments, the array is built by combining line replaceable units (LRUs) comprising 64 elements that can be further divided into 16 miniarrays, each having 4 elements.

FIG. lA shows a bowtie antenna element 10 (or more simply antenna 10) manufactured using an additive manufacturing technology (AMT) manufacturing process including a radiator 12 (e.g., a slot aperture) having a general "bowtie" shape milled into a surface 14a of a dielectric substrate 14. Substrate surface 14a is provided having an electrically conductive material 16 (e.g., copper or an equivalent conductive material) disposed thereover (a portion of conductor 16 has here been removed to reveal a portion of dielectric substrate surface 14a). The bowtie shape radiator 12 is formed by an AMT milling operation which removes the conductive material 16 and then printing a conductor to form radiator 12. In some embodiments the conductive material 16 is provided as copper having a thickness of 0.007 inch. In this case, the slot aperture conductor would also be about 0.7 mils (18 microns) thick.

It should, of course, be appreciated that in other embodiments, other conductive materials and thicknesses may also be used. It is understood that the conductor thickness is selected to excite the bowtie radiator 12 in a desired manner. In embodiments, a thickness of the conductor is in the order of 0.005 mils.

Bowtie antenna element 10 further includes first and second sets of tuning elements 18, 20. The first set of tuning elements 18 includes a two pairs of conductors 22a, 22b with each conductor in the pair having a rectangular shape. The second set of tuning elements 20 includes a two pairs of conductors with each conductor in the pair having a square shape. The first set of tuning elements 18 and the second set of tuning elements 20 are formed by an AMT milling operation which removes the conductive material 16 as well as substrate material 14 so as to form an opening in the substrate having the desired shape of the tuning element (here, pairs of rectangular and square shapes). A conductive ink (or more generally a conductive fluid) is then disposed in the openings to form the first set of tuning elements 18 and the second set of tuning elements 20. With this technique, an antenna element having a geometry which is relatively simple compared with geometries of prior art antenna elements having similar operational characteristics (e.g., frequencies of operation, bandwidth characteristics, gain characteristics, etc.) is provided.

CLAIMS

[Claim 1] An array antenna comprising four low profile arrays (LPAs),

(a) wherein each of the four LPAs comprises:

(i) an antenna element array layer having at least one Faraday wall; and

(ii) a beamformer circuit layer coupled to the antenna element array layer, the beamformer circuit layer having at least one Faraday wall, wherein the Faraday walls extend between ground planes associated with at least one of the antenna element array layer and the beamformer circuit layer, and

(b) wherein the four LPAs are arranged such that a first set of tuning elements of a first LPA and a first set of tuning elements of a second LPA are respectively adjacent to a second set of tuning elements of a third LPA and a second set of tuning elements of a fourth LPA.

[Claim 2] The array antenna according to claim 1, wherein each of the four LPAs has a total thickness of less than 1.18 mm.

[Claim 3] The antenna array according to claim 1, wherein the antenna element array layer further comprises a substrate, a conductor on the substrate, and a radiator.

[Claim 4] The antenna array according to claim 3, further comprising a vertical launch that extends through the radiator of the antenna element array layer and the beamformer circuit layer.

[Claim 5] The antenna array according to claim 4, further comprising a logic circuit layer below the beamformer circuit layer.

[Claim 6] The antenna array according to claim 5, further comprising a phase shift layer below the logic circuit layer.

[Claim 7] The antenna array according to claim 6, wherein the vertical launch extends through the logic circuit layer and the phase shift layer.