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WIDE BEAMWIDTH QHA FOR RS SATELLITES AND GROUND STATION APPLICATIONS

Abstract

In this paper, it has been shown that the axial ratio beamwidth of conventional QHA can be improved by breaking the four monofilars at the center where current is minimum and adding radial stubs on both sides which provides reactive coupling between the two ends. The axial ratio beamwidth (AR $\leq$ 3 dB) varies from 116° to 240° as the length of the radial stubs is increased from 0 mm to 40 mm in all monofilars, keeping the front to back ratio greater than or equal to 10 dBs. The optimum value of axial ratio beamwidth of 240° is achieved when the radial stub length is 24 mm. The gain, 3-dB beamwidth, bandwidth for VSWR $\leq$ 2 (with reference to the resonant input impedance) and F/B ratio are 5.6 dB, 116°, 40 MHz, 19.71 dB respectively. Simultaneously, the configuration achieved a reduction in size of approximately 22 %.

Improving axial ratio beamwidth is very critical for systems which employ circular polarization because the transmitting and receiving antennas are not sensitive to polarization orientation when their signals are circularly polarized. As in LEO satellites, onboard antennas use circular polarization owing to the continuous change in the direction between satellite and ground receiving antenna that would in case of linear polarization require polarization adjustment.

Axial ratio beam width is also important where angle between the transmitting and receiving antennas changes significantly as in LEO satellites over a single pass window. QHA, with wide gain beamwidth ensures sufficient received power without introducing polarization losses, if the 3 dB gain beamwidth falls within the AR beamwidth. If the AR beamwidth is narrower than the 3 dB gain beamwidth, polarization loss would introduce additional decrease in gain. Therefore wide AR beamwidth antennas are important for onboard use of LEO/MEO satellites, especially at low elevation angles where normally AR deteriorates quickly.

In this work, it has been shown that we can improve the 3 dB AR beamwidth by incorporating radial stubs in the antenna structure that will allow us to improve the LEO satellite pass window. This means communication link can be established for larger time and better data transfer can be achieved. By doing this, we are losing the received signal strength as we will be operating below the HPBW of the antenna but we are compensating through good AR.

Keywords: Quadrifilar Helix antenna (QHA), Axial Ratio (AR).