Compact quadrifilar helix antenna with embedded feed network

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***Abstract*—A compact quadrifilar helical antenna with embedded feeding circuit is presented in this paper.**

I. Introduction

Compact circularly polarized antennas with broad radiation pattern are widely used in many communication systems including telecommand transmission channels for small satellite applications. For example, circular polarized antennas are used for GNSS and GLONASS operation. There is a wide variety of antennas that have circular polarization, the most commony used are

- patch antennas
- helical (including quadrifilar helix) antennas
- turnstile antennas

Polarization of a simple helical antenna strongly depends on its geometry. Thin antennas (circumference $C < 0.5\lambda$) is excited by a normal mode and radiates lineary polarized wave. However, generation of CP wave requires larger diameter ($C \approx \lambda$). This demand may be relaxed if in case of quadrifilar helix antennas (QHA). They have an exceptional property of radiating CP wave regardless of it's diameter.

Each class of these antennas may be further subdivided into two major subclasses:

- self-phased antennas
- with external phasing circuits

Self-phasing is a techinque that allows generation of circular polarized (CP) wave using two orthogonal linear polarized sources. These sources are tuned to resonate at above and below the central frequency so that phase shift between the sources is $90°$ at central frequency. Provided the currents in these sources are equal, such system generates CP wave if fed by single source without need in any external splitters and phasing circuits. This method is widely used in building CP antennas of all the mentioned types. It has the advantage of simplicity and low cost. However, self-phased antennas are usually narrowband (less that 1 percent) not just in terms of return loss: their axial ratio (AR) degrades rapidly with offset from center frequency.

Another option is a phasing circuit. There are several demands to the feed network:

- equally split input power between output ports
- provide phase progression of $90°$ between adjacent ports
- provide impedance matching between source and loads.

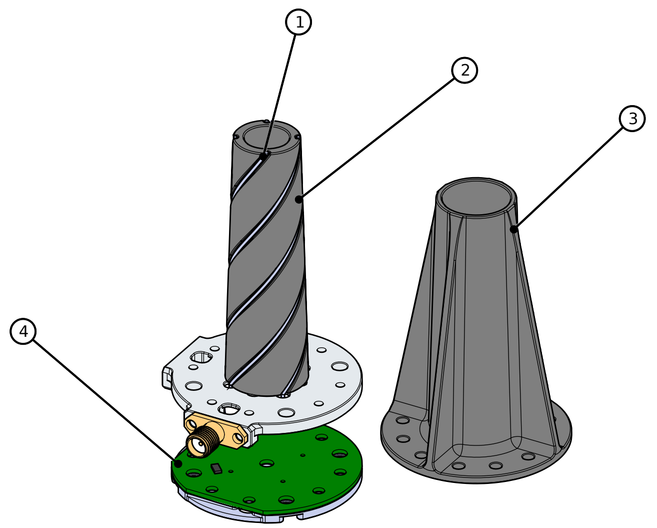

Fig. 1. QHA exploded view. Four helix arms (1) reside inside grooves on inner dielectric cone (2). This assembly is in turn covered by outer dielectric cone (3) and is placed on the aluminum case. Helices and SMA connector are soldered to the ports of the PCB (4).

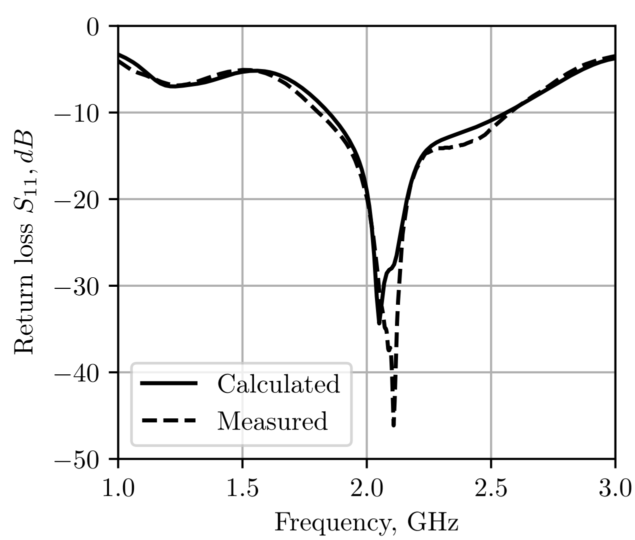

Fig. 2. Simulated and measures return loss of the feed network with attached QHA. Center frequency for both plots is $F_c = 2.08\ GHz$, calculated bandwidth is $BW_{calc} = \pm 3.6\%$, measured bandwidth is $BW_{meas} = \pm 3.8\%$

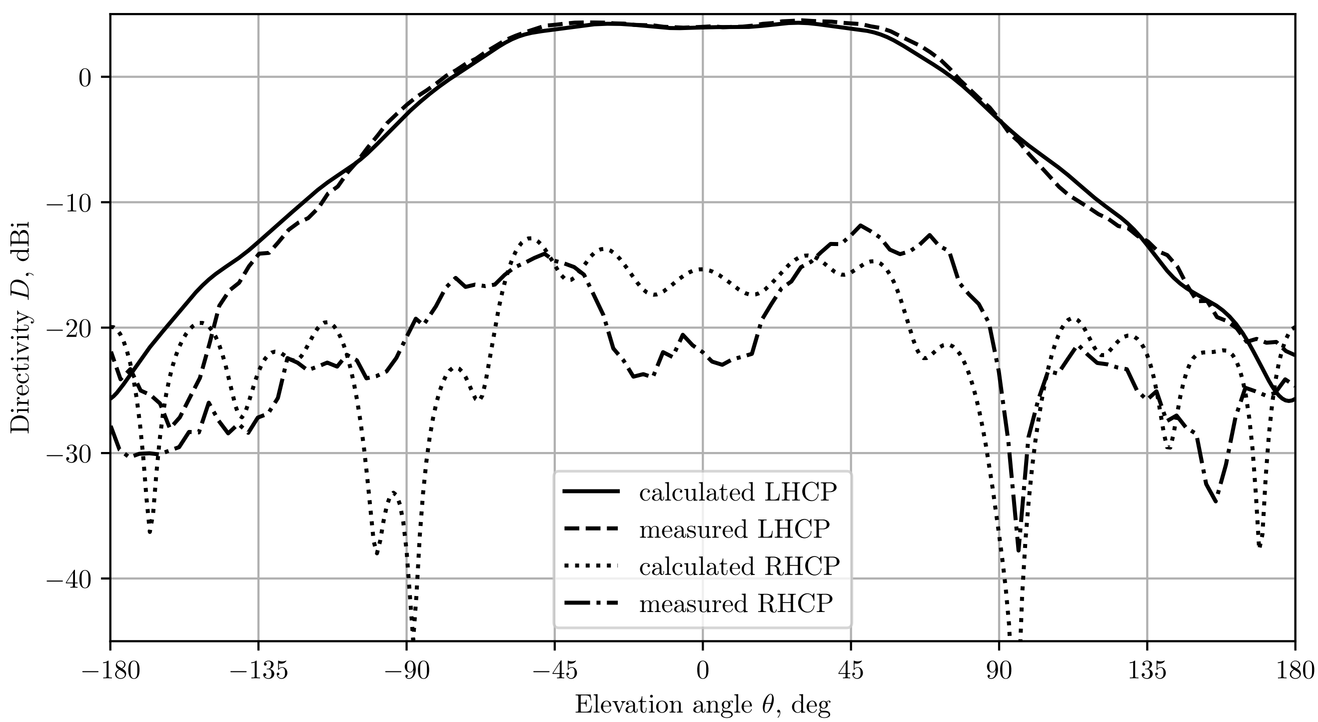

Fig. 3. Directivity