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# A Multifunction Antenna: Radar and QPSK Comms

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**Abstract**—An antenna system for C-band composed of a horn and an independently controlled slotted waveguide using a single source is presented. The radar function is served by the horn antenna and the communication function by the direct modulation on the slots of the feeding waveguide.

**Keywords**—multifunction, radar, communications, direct modulation, horn antenna, slotted waveguide, C band

## I. INTRODUCTION

In previous works [1] [2], the authors have developed a multifunction antenna using a horn (for the radar function) and a slotted waveguide (for the communication function) with a single source. In this way the comms radiation is in another direction with respect to the radar radiation but also has orthogonal polarization. For the comms function, direct modulation (turning on or off) on the slots was used for a Binary Phase Shift Keying (BPSK) modulation. In this work we extend the possibility to Quadrature Phase Shift Keying (QPSK) direct modulation, which shows how to implement higher PSK modulations.

## II. ANTENNA SYSTEM

**Radar function:** we consider a C-band horn antenna: truncated pyramid of height 15.13 cm, base 18.1 cm x 12.6 cm, top (waveguide feeding) 4.75 cm x 2.2 cm ([2], Figure 1).

**Communication function:** we consider a waveguide WR-187, with section 4.75 cm x 2.2 cm. Four slots are etched in the waveguide wall as shown in Figure 1. As explained in [1] [2], slots at same with identical  $x$  coordinates but with opposite  $y$  coordinates radiate out of phase. To obtain phase quadrature, we add a horizontal displacement corresponding to a quarter wavelength in the waveguide ( $\lambda_g/4$ ). In this way, turning on and off each of the slots (one at a time as shown in Figure 2) we can obtain the four phase states needed for QPSK modulation. Generalizing, a combination of vertical and horizontal displacements can be used for higher PSK modulations.

## III. RESULTS FOR RADAR AND QPSK COMMS

The simulations were done in FEKO and are shown for different cuts at 5 GHz in Figure 2. The radar gain (Theta gain,  $\theta = 90^\circ$ ) is 16 dB and the slot radiations (Phi gain,  $\theta = 0^\circ$ ) have a gain of  $-0.6 \text{ dB} \pm 0.3 \text{ dB}$  and phases around  $0^\circ, 90^\circ, 180^\circ$  and  $270^\circ \pm 5.3^\circ$ . This gives a very low error vector

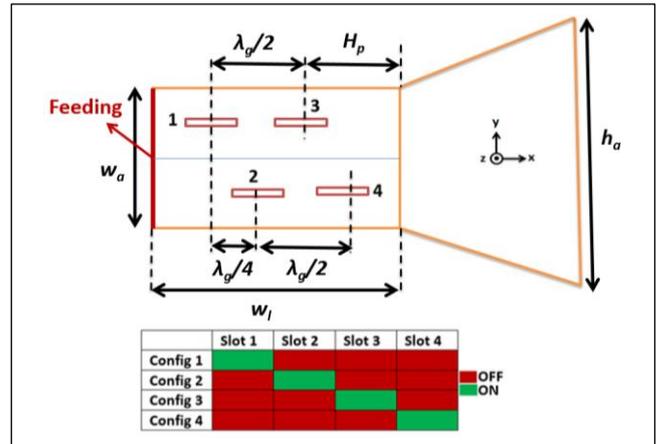


Figure 1: Antenna system configurations and physical characteristics ( $w_a = 4.75 \text{ cm}$ ,  $w_b = 2.2 \text{ cm}$ ,  $w_l = 13.5 \text{ cm}$ ,  $h_l = 13.5 \text{ cm}$ ,  $h_b = 12.6 \text{ cm}$  and  $h_a = 18.1 \text{ cm}$ ,  $d = H_p = 3.6 \text{ cm}$ )

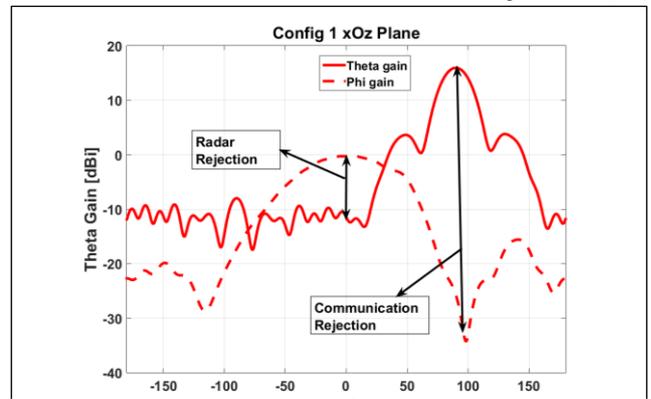


Figure 2: Radiation characteristics at 5 GHz

magnitude (EVM, -20 dB). Additionally, as shown in Figure 2, the communication radiation is below 35 dB from the radar (comms rejection), and 10 dB vice versa (radar rejection).

## REFERENCES

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