VHF communication antenna for integration into an aircraft winglet

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***Abstract*— This contribution presents the final design of a VHF notch antenna integrated in the winglet of the EV55 aircraft.**

***Index Terms*—antennas, aeronautics, integration.**

I. Introduction

Within the H2020 project ACASIAS [1], Work Package 4 deals with the integration of VHF antennas for air traffic control into the winglets of the Evektor EV55 small transport aircraft. The VHF antenna must operate in the VHF band reserved for civil aviation, 117.975 – 137 MHz (156MHz for extended VHF band), with maximum gain of 2.15 dBi [2].

II. Winglet Antenna Design

A. *Integrated notch antenna*

The chosen concept is a notch antenna [4] printed on a thin, flexible PCB sandwiched in the foam filling of the winglet. The open side is tapered for broadband matching. The winglet geometry is presented in Fig. 1 [3].

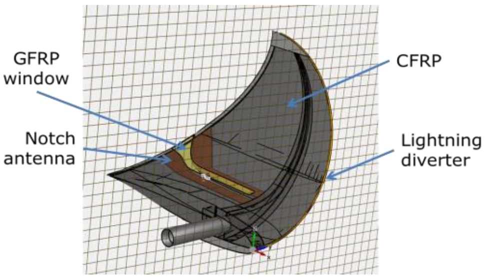

Fig. 1. EV55 winglet with integrated notch antenna

The outer skin of the winglet is made out of Carbon Fibre Reinforced Plastic (CFRP), modelled as a sheet resistance with R_S= 0.05 Ω/sq [6], [7], and covered with a copper mesh for lightning protection, so that a Glass Fibre Reinforced Plastic (GFRP) "window" was scarfed on the winglet skin to allow the antenna to radiate. The simulation results for different feeding points are presented in Fig. 2 and Fig. 3.

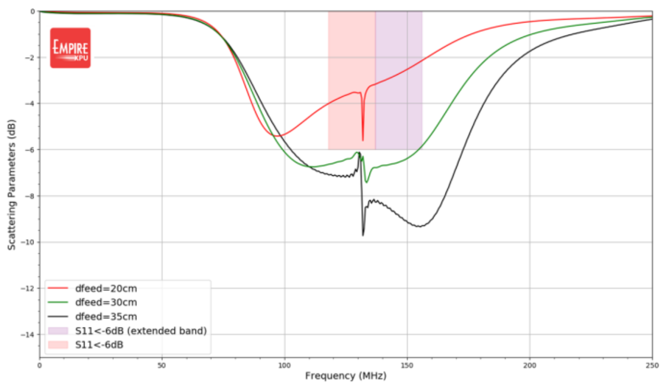

Fig. 2. Simulated reflection coefficient of the notch antenna in the winglet vs. feeding point position.

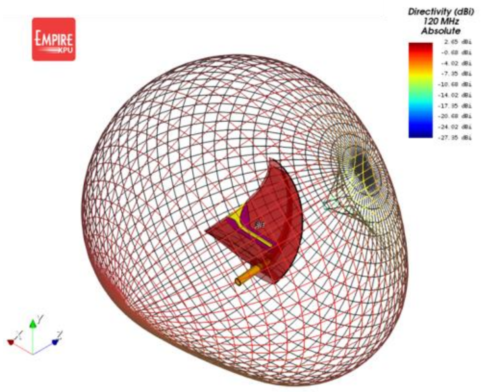

Fig. 3. Simulated radiation pattern (directivity), integrated notch antenna.

B. *Preliminaty measurements*

A reduced model of the winglet skin (Fig. 4) was used for a preliminary characterisation of the integrated notch antenna's properties. The measured reflection coefficients are presented in Fig. 5 for two different feeding cables: a conventional semi-rigid coaxial cable and an innovative flat, flexible transmission. In both cases, good results were obtained concerning the antenna matching and bandwidth.

Fig. 4. Preliminary sample of the winglet skin: top view and cross-section of the scarfed GFRP window.

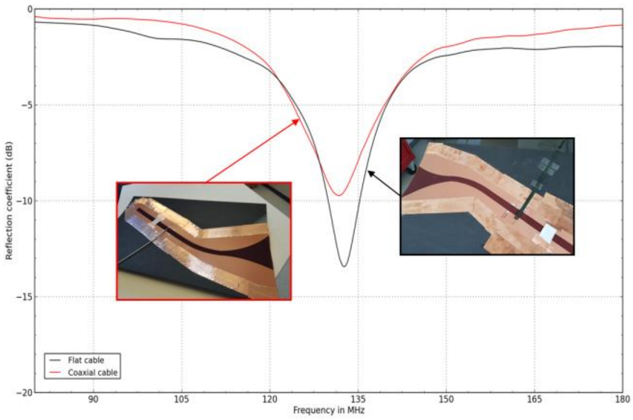

Fig. 5. Measured reflection coefficient of the notch antenna in the winglet with coaxial and flat cable.

III. FULL AIRCRAFT INTEGRATION

A. *Electromagnetic performance*

The integration of two winglets antennas on the EV55 aircraft was also simulated. Impedance matching better than -6dB is still achieved, as shown in Fig. 6.

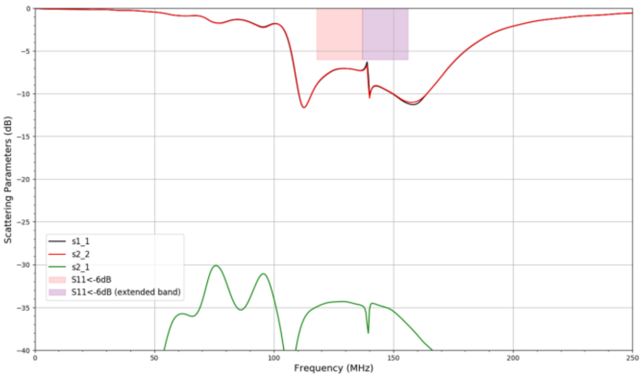

Fig. 6. Simulated reflection coefficient and coupling of two notch antennas on the EV55.

As in the case of any antenna mounted on an aircraft, the radiation patterns are affected by the presence on the aircraft's wings and body, leading to shadowing and radiation minima, as shown in Fig. 7. Nevertheless, the two notch antennas are clearly decoupled, with an envelope correlation coefficient ECC=0.0031, so that diversity strategies can be used to improve the system performance.

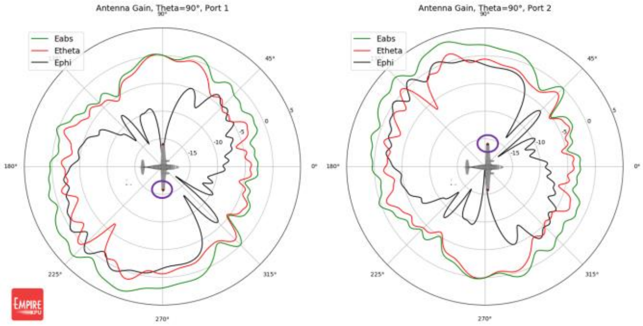

Fig. 7. Simulated azimuth gain of two notch antennas on the EV55.

B. *Lightning protection*

Both the winglet structure and the VHF antenna have to be designed in a way to survive a possible lightning strike event. Protective measures used to diminish both direct and indirect effects of a lightning strike include a diverter system situated on the leading edge of the winglet, optimized layup of winglet's CFRP parts and shielding as well as filtering elements to prevent introduction of transients into the airborne wiring and vulnerable avionics.

IV. CONCLUSIONS

Proposed concept of the VHF antenna and its integration represents a promising way how to utilize winglet from more than one perspective. However, such the design is more demanding due to a higher number of specific technical aspects that are necessary to be taken into account.

ACKNOWLEDGMENT

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