Structural Integration of Ku-band SatCom Antenna into novel Fuselage Panel

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ABSTRACT

The main objective of the ACASIAS project is to contribute to the reduction of energy consumption of future aircraft by improving the aerodynamic performance through conformal and structural integration of antennas that are normally protruding. This paper deals with the conformal integration of an electronically steerable a Ku-band antenna for satellite communication, which does not require anymore a protruding radome.

In the ACASIAS project a composite stiffened orthogrid fuselage panel is developed for integration of Ku-band SATCOM phased array antenna tiles. The Ku-band antenna tiles to be integrated are based on the antenna tiles that were developed in a previous FP7 project called SANDRA. In the SANDRA project the focus was on the functional performance of the antenna tiles. In the ACASIAS project the focus will be on the integration of the antenna tiles in a fuselage panel, taking into account integration aspects like thermal control and lightning protection. Structural aspects of the composite fuselage panel will be presented. The ribs of the orthogrid will be made of Carbon Fibre Reinforced Plastic (CFRP), while the skin will consist partly of CFRP and Glass Fibre Reinforced Plastic (GFRP). The GFRP skin is necessary to enable the electromagnetic radiation from the antenna underneath it.

A complete array of 24 antenna tiles will be designed and manufactured. However, not all tiles will be real antennas. Some tiles will only have passive components (resistors) and will not operate as an antenna. The thermal behaviour of these dummy tiles will be representative for the real antenna tiles. The antenna tiles will have built-in cooling solutions. These cooling solutions and thermal behaviour of the antenna tiles will be discussed in a separate paper. This paper will focus on the electromagnetic aspects of the antenna integration: the influence of the fuselage structure and lightning protection on the behaviour of the satcom antenna.

The radiation pattern of the array antenna will be determined by the layout of the antenna tiles and the separation between the antenna tiles. Too large a separation may introduce grating lobes in the radiated pattern. Therefore the thickness of the ribs of the Orthogrid has to be taken into account in the design of the antenna array. In addition, the influence of the material of the ribs on the radiation pattern has to be taken into account. The CFRP ribs of the orthogrid are conductive. In the design of the antenna elements and antenna tiles the conductivity of the ribs will have to be taken into account, especially under scanning conditions of the antenna. The skin of the fuselage panel above the antenna tiles is transparent to enable the electromagnetic radiation by the antenna. Therefore the complex permittivity of the GFRP material will be determined to assess the transmission, reflection and absorption properties of the GFRP skin for Ku-band waves.

The lightning protection for the antenna will be applied in two stages: The antenna elements will have both stacked patches grounded using a connecting via in the centre of the patch. In this location the grounding via will have no influence on the electromagnetic performance of the antenna element. In addition some kind of lightning diversion will be added to the non-conductive GFRP skin. The influence of the lightning diverters on the performance of the satcom antenna will be taken into account in the design.