Exploration of radiating aerostructures – ultimate antenna and structure integration

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ABSTRACT

This paper will outline aspects, outcome and prospects of full integration of antennas into structural elements of aircraft, from an antenna design perspective.

Full integration in this respect means making the antenna function an integral part of the structural component. Structural components in this regard are meant to be structural aircraft elements that fulfil a load-bearing function.

Conventionally, antennas are installed as separate components onto the exterior of fuselages. Thus, they will produce aerodynamic drag by protruding into the airflow over the fuselage skin during flight. Integrating antennas into the fuselage skin should smoothen the fuselage skin, and therefore minimize aerodynamic drag.

The protruding antennas are conducting structures on which electric currents flow. These changing electric currents produce changing electric and magnetic fields (electromagnetic waves).

Fibre Metal Laminate (FML) is a composite aircraft construction material, consisting of metal layers that are bonded with fibre layers and resin to form a cohesive laminate. Since the core fibre layer within the laminate is electrically insulating, exciting the metal layers with an RF voltage could create electromagnetic fields and thus the layers could act as an antenna. Especially (stacked) patch antennas, e.g. as used for GNSS reception, could be well implemented in FML.

Instead of using the metal as a radiating antenna, a slot could be used as an antenna. By exciting the slot with a changing voltage, the slot will also radiate electromagnetic fields. The slot antenna is actually the complement of a dipole antenna. A slot antenna could be used for VHF communication.

Research and investigation has been undertaken for this subject in order to respond to the demand and wish of aviation industry for more energy efficient aircraft. The focus has been to use the mechanical properties of FML and combine these with the functional needs of antennas, whilst not disturbing the fuselage exterior.

Two types of antennas (a stacked patch antenna and a slot antenna), which enable integration within an aircraft fuselage skin, have been chosen for this research. Each antenna is used for a different application in terms of operating frequency and direction of radio wave propagation.

The paper will not only describe the design, but also discuss the characteristics thereof that led to the ultimate design; such as limitations and constraints found, and compromises and mitigations taken. Initial simulations and breadboard tests showed promising results that will be validated during antenna performance testing.