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BILBO Network: a proposal for communications in aircraft Structural Health Monitoring sensor networks

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Abstract. In the aeronautical environment, numerous regulatory and communication protocols exist that cover interconnection of on-board equipment inside the aircraft. Developed and implemented by the airlines since the 1960s, these communication systems are reliable, strong, certified and able to contact different sensors distributed throughout the aircraft. However, the scenario is slightly different in the structural health monitoring (SHM) field as the requirements and specifications that a global SHM communication system must fulfill are distinct. The number of SHM sensors installed in the aircraft rises into the thousands, and it is impossible to maintain all of the SHM sensors in operation simultaneously because the overall power consumption would be of thousands of Watts. This design of a new communication system must consider aspects as management of the electrical power supply, topology of the network for thousands of nodes, sampling frequency for SHM analysis, data rates, selected real-time considerations, and total cable weight. The goal of the research presented in this paper is to describe and present a possible integration scheme for the large number of SHM sensors installed on-board an aircraft with low power consumption. This paper presents a new communications system for SHM sensors known as the Bi-Instruction Link Bi-Operator (BILBO).

Keywords: aeronautic; communications; electrical power supply; structural health monitoring; sensor network

1. Introduction

Maintenance of aircraft structures is a key focus for aircraft operators. The complexity of the systems involved requires extensive maintenance for all elements, including hydraulic, propulsion, electrical, avionics, and structural systems. The structural integrity is one of the most critical concerns in the airspace industry. During the fabrication process, all aeronautical elements must pass many tests and certifications carried out by aeronautics manufacturers and airworthiness authorities, i.e., the Federal Aviation Administration (2014) in the United States of America or the European Aviation Safety Agency (2014) in Europe. Furthermore, during the lifetime of an aircraft, airlines and other commercial operators of large or turbine-powered aircraft follow a continuous and detailed inspection program approved by these authorities. In a perfect scenario, all of the structures would be permanently monitored from the manufacturing process to the end of the life cycle, including the transportation, the installation, the deterioration process, and any impacts

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- The electrical power consumption of the overall system has been estimated. With this BILBO Network architecture, 1000 on-board SHM sensor installations and a sampling frequency of 15 min, it is possible to operate with a power supply of 150-200 W. It would also be possible to power up 10,000 SHM sensors using less than 2000-3000 W in the same period of time.

A laboratory prototype has been designed, built, and installed to validate this strategy and this architecture. BILBO Network has been tested and validated.

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