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DESIGN OF A FIBER-OPTIC INTERROGATOR MODULE FOR THE HYBRID SENSOR BUS SYSTEM FOR TEMPERATURE MONITORING IN TELECOMMUNICATION SATELLITES

Abstract

In this paper the concept and design of the fiber-optic interrogator module of the Hybrid Sensor Bus (HSB) for telecommunication satellites, developed in the frame of an ESA-ARTES program, is presented. The final system will be verified as flight demonstrator onboard the German Heinrich Hertz satellite in 2016. Fiber-optic sensing onboard satellites is a new concept allowing the implementation of novel control and monitoring methods.

In state of the art European telecommunication platforms, hundreds of point-to-point wired sensors are necessary for satellite control and monitoring. The traditional wiring method results in a high mass impact but primarily increases AIT effort and thereby the overall satellite production costs. Sensor bus architectures reduce AIT cost by lowering the wiring effort, decreasing the required test time and by providing a flexible sensor network topology.

The HSB system uses a modular approach based on open standards. The HSB system shall provide advanced performance which includes sensor set selection, implementation of specific alarm functions and averaging of dedicated sensors. This results in a reduction of SMU processor load because an interrupt based communication between SMU and HSB system can be established. The HSB system benefits from fiber Bragg grating (FBG) based fiber-optic sensing because of the intrinsic sensor distribution capability and the possibility to embed optical fibers in composite structures like tanks and panels.

The fiber-optic interrogator module implemented in HSB is based on a monolithic laser diode where the output wavelength is spectrally tuned by electric control signals. By evaluating the intensities of the reflected light dependent on the wavelength of the laser, the peak of the FBG can be monitored. The correct evaluation of the peak is a challenging task, therefore different methods are presented, namely centroid, finite impulse response filter and curve fitting algorithms. The spectral position of the peak and its relative shift is the direct indicator for temperature changes. The above mentioned algorithms are assessed in terms of suitability (minimized load vs. measurement performance) for FPGA implementation and robustness with regard to laser degradation and measurement noise.

In this paper we present the HSB system, in particular the design of the fiber-optic interrogator module and simulation results of the FPGA based FBG evaluation algorithms. Taking into account the inputs

from the German platform manufacturer OHB System, the results will verify the compliance of the HSB system with the requirements of telecommunication satellites.