Using Fault Injection on the Nanosatellite Subsystems Integration Testing – IAA-LA-11-01

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Since the 2000's, an increased number of nanosatellites have accessed space. However, studies show that the number of unsuccessful nanosatellite missions is very expressive. Moreover, these statistics are correlated to poor verification and validation processes used by hobbyists satellite developers because major space agencies keep high successful ratings even with small/nano satellites missions due to its rigorous V&V processes. Aiming to improve payloads integration testing of NanosatC-BR-2, a 2-U Cubesat based nanosatellite under development by INPE, the fault injection technique has been used. It is very useful technique to test systems prototypes. This paper presents the design and implementation of a Failure Emulator Mechanism (FEM) on I^2C communication bus for testing the interaction among the NanosatC-BR2 subsystems, supporting interoperability and robustness requirements verification. The FEM is modelled to work at the communication bus emulating eventual faults of the communicating subsystems in the messages exchanged. Using an Arduino board for the FEM and NI LabView environment it is possible to program the mechanism to inject different faults at the I^2C bus during different operation modes. Based on a serial architecture, the FEM will be able to intercept all messages and implement different faults as service (i.e. message lost, bit flip and other single upset events) and timing (i.e. delay) faults. The FEM interface with the tester is designed in LabView environment. Control and observation facilities are available to generate and upload the faultload script to FEM Arduino board. The proposed FEM architecture and its implementation are validated using two subsystems under testing prototypes: the OnBoard Data Handling Computer and the Langmuir Probe NanosatC-BR2 payload. For this analysis purpose, the prototypes simulate in two different Arduinos boards the expected behavior of each subsystem in the communication.

Keywords: FEM, Fault Injection, CubeSat, nanosatellite, V&V, tests.