

Digital Integrated Pyrotechnic System

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Pyrotechnic systems (i.e. initiators, transmission lines, time delays, rod cutters...) are key elements for space launch vehicles and military aircrafts as they fulfill critical functions like engine starting, booster or canopy separation and distancing, seats ejections etc. Existing pyrotechnic devices are reliable and robust but also heavy, quite large and complex. Furthermore, their installation is relatively costly due to their hazardous characteristics. Importantly, they also have to be regularly replaced to ensure high reliability level requirements.

In this context, DASSAULT-Aviation in collaboration with the French Space Agency (CNES) and the LAAS-CNRS has proposed a new technological solution suitable for next generation launchers and aircrafts in replacement of classical pyrotechnic devices. It is based on smart and safe PyroMEMS interconnected and communicating via digital bus. This work relies on the knowledge of LAAS-CNRS in nano energetics and micro technology integration, and on DASSAULT-Aviation skills in pyrotechnics engineering.

First, major innovation lies in the use of a numerical bus for the command distribution instead of pyrotechnic communication solutions. Transmission lines, multi-ways relay and time delay can also be replaced by electric wires and digital clock which is of course lighter, easier to install, robust and therefore not to be replaced regularly. Using a numerical bus also allows two way communications and thus, data-gathering of pyrotechnic system state (i.e. the different initiators arming state). This constitutes a significant improvement in terms of overall systems security and reliability.

The second innovation consists in charging up the electrical energy for the initiator firing into the initiator itself. This way, pyrotechnic system does not need large battery to run on. Indeed, electrical energy does not have to be delivered in one go (for the initiator firing) but rather in a much longer time for the initiators charge-up.

System protocol and modularity enable two separate command sources: one for safety operations (i.e. electrical protection, mechanical arming...) and another one for operational steps (i.e. electrical energy charging/discharging, direct or delayed firing, self-test procedure...). This way, system is secured against a potential malfunction of one of the two different command sources. As the whole pyrotechnic chain

(command, distribution and pyrotechnic devices) is replicated, the system is also fail-safe and fail-operational.

This new pyrotechnic architecture leads to the development of a smart and safe initiator, able to communicate on a numerical bus and also to charge up electrical energy. This initiator is compatible with terminal functions using the European Standard Initiator (ESI). It includes energy storage, mechanical arming system, electrical protection circuitry, and also a micro controller that drives the different elements and communicates with the numerical bus.

This paper presents the conception of the digital integrated pyrotechnic system that could constitute a real breakthrough for next generation of embedded Pyrotechnical Systems.

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