KONGSBERG

Optopyrotechnics for Next Generation Launchers Executive Summary

Report

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Scope

This document constitutes the Executive Summary for the Optopyrotechnics for Next Generation Launchers (GSTP) project. The objective of this project was to demonstrate TRL 6 and IRL2 for the entire sub-system, and hence make Opto-Pyrotechnics technology available to future launchers. As can be seen from the Figure 1, the Optopyro sub-system consists of a Laser Firing Unit (LFU) that provides high intensity laser pulses, an Optical Harness (OH) to relay the laser pulses, and an Optical Safety Barrier (OSB) that can block any unintended laser light while the launcher is on the ground. The project took the LFU to Preliminary Design Review (PDR) level, but focussed on prototyping and testing the OSB after PDR. The Laser Initiated Devices (LID) initiate the function when receiving the laser pulses.

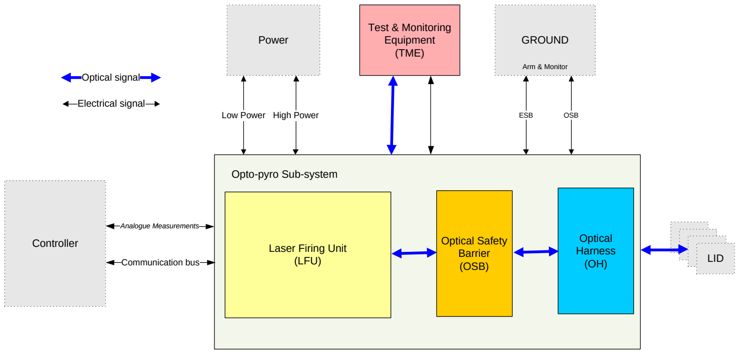

Figure 1 Optopyro sub-system

Functional Design

In the Optopyro sub-system studied by KDA, the Laser Initiated Devices were not included in the sub-system. As illustrated in Figure 2, a prime function of the Optopyro sub-system was therefore to Provide Light Pulse. The Optopyro sub-system is also equipped with a function “Be Safe” to increase safety on ground. This function is implemented with the sub-system blocking current to the laser diodes and through blocking of light from the laser diodes to the LIDs. The sub-system is also required to provide telemetry on its status and therefore has a “Verify” function.

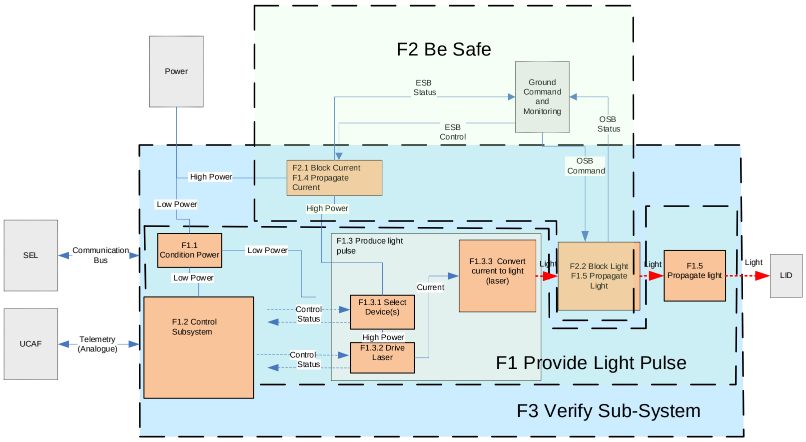

Figure 2 Optopyro Subsystem Function Diagram

The Laser Firing Unit

The Laser Firing Unit interfaces with the on-board bus and effectuates firing commands by providing electrical current to the laser diodes when the pyrotechnical function is required. The Laser Firing Unit also provides telemetry on the state of the internal controller, the laser drivers and on the Electrical Safety Barrier.

KDA produced a critical breadboard of the LFU where the laser driver was based on a switched mode design with the current regulated to a fixed value set by a reference voltage. In support of this study, KDA initiated the development of a rugged high intensity laser with a laser manufacturer. The laser diode developed had a 980nm wavelength and a minimum 11.83W of output power on a 105/125um, NA=0.22 fiber in all relevant environments.

The critical breadboard with the rugged high intensity lasers underwent functional and thermal tests and demonstrated the capability of firing four laser diodes simultaneously.

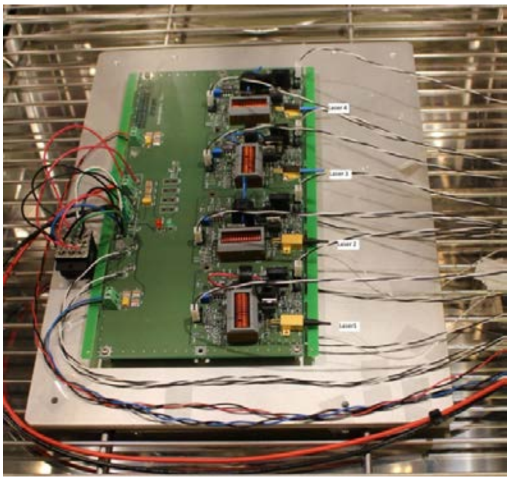

Figure 3 LFU Critical Breadboard undergoing thermal test

The Optical Safety Barrier

KDA developed an OSB that was representative in form fit and function, and which was subject to the full suite of tests including functional, thermal and humidity, vacuum and pressurization, shock and vibration, and EMC and ESD tests. Overall, the tests were successful. The OSB in the thermal test chamber is shown in Figure 4 below.

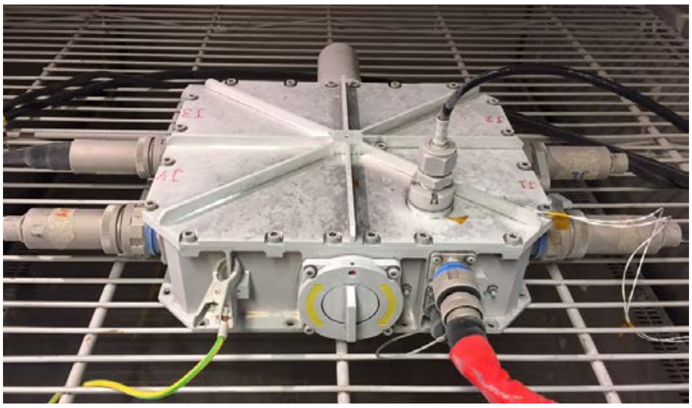

Figure 4 OSB Engineering Qualification Model at cold temperature

Conclusions

The project has successfully matured critical parts of the Optopyro sub-system, and the study has benefited the optical technologies such as the laser diodes and the OSB in particular. We foresee that no new electronics and mechanical technologies are required to implement the Optopyro sub-system on the launcher, although a significant effort would be required to produce a design that meets the launcher needs. It is furthermore noted that there is currently no mature technology available to verify the optical chain after mating of the last connector to be mated, and some effort is still required to mature the Optical Harness.

The test campaign showed that the optical harness is sensitive to contamination or imperfections on the fiber ends since the high optical power could lead to damage. Also, we found that the optical transmission in the optical connectors could not be guaranteed during shock. We expect this to be rectified during the ongoing effort by the manufacturer of the optical connectors to develop flight compatible connectors and fiber harnesses.

One of the prime challenges for Ariane 6 will be to industrialise the technology, improve ruggedness and bring cost down to meet the launcher needs. Further effort is also required on verification of equipment in production and of the optical chain during integration on the launcher.