

Fiber Optics in Space

Optical Switch Proves its Worth Aboard ISS

All components for use in space must undergo intensive and detailed testing until their space suitability can be determined. The qualification of equipment and components for space missions is, therefore, a long and costly process. To reduce the mission risk, it is useful to have a so-called technology demonstrator, to be tested early and under real conditions. One current example of this is a fiber optic switch supplied by Laser Components to the space company OHB, which was qualified for a space experiment aboard the International Space Station (ISS). In the future, it will be used in an Exobiology Facility.



Space Research

The European Space Agency is developing a novel Exobiology Facility to be accommodated outside the International Space Station (ISS). Exposure platforms like the Exobiology Facility in Low Earth Orbit (LEO) – with the possibility for long-duration solar exposure – are ideal for investigating the effects of solar and cosmic radiation on various biological and non-biological samples. Up to now, the exobiology and space science research community has successfully made use of the ISS via the EXPOSE Facility to expose samples to the space environment with subsequent analyses after returning to Earth. The new platform will combine the advantages of the ISS, i.e., long-term exposure and sample return capability, with near-real-time in-situ monitoring of the chemical or biological evolution of samples in space. In particular, ultraviolet-visible (UV-Vis) and infrared (IR) spectroscopy are considered to be key non-invasive methods for analyzing the samples in situ. To acquire the spectra of many samples, which are necessary for statistical reasons, one of the key instruments is an optical fiber switch, combined with the ultraviolet-visible spectrometer.

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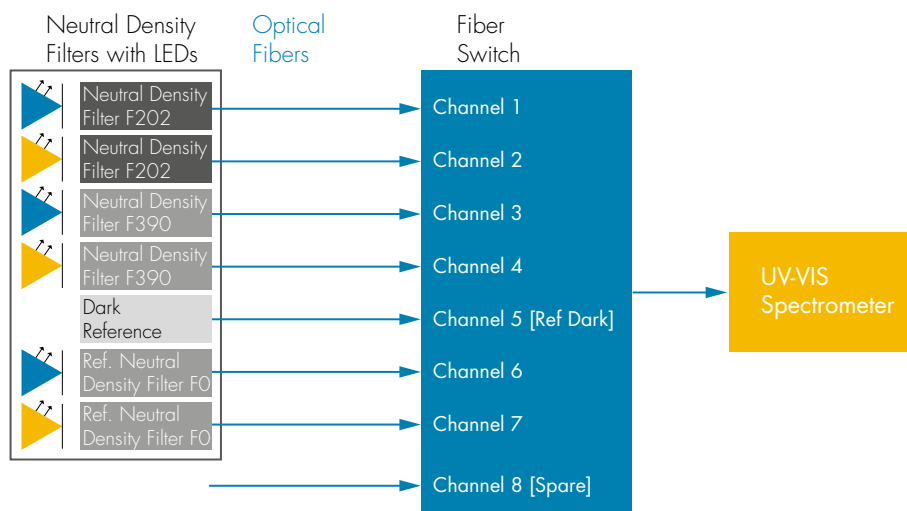
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Optical Technology Demonstrator

SPECTRODemo has been developed as a precursor demonstrator to increase the maturity of the complete optical chain, i.e., the fiber switch and spectrometer. The payload was launched on April 17, 2019 and operated continuously until August 9, 2019. The technology demonstrator was operated aboard the ISS within the ICE Cubes Facility – a small modular container which measures 2Ux2U, where 1U=10x10x10 cm³.

The demonstrator provides useful information for the upcoming development of the Exobiology Facility flight model, especially with respect to the operation, durability, and reliability of the fiber switch.



Internal structure of the SPECTRO Demo: a demonstrator of optical technologies for space research

In the fiber switch concept, each cell is associated with its own dedicated multimode optical fiber. A switch unit is used to select the fiber that is measured by the spectrometer, which allows a higher flexibility in sample handling in a compact design. The configuration of SPECTRODemo supports continuous acquisition across six channels, with each channel recording a spectrum from a defined LED source through a calibrated neutral density filter with a fixed absorbance value.

The main objective is to assess the reliability of the system and potential modifications to assure repeatable measurements and suitability for the harsh environment of space. Consequently, an environmental test campaign was performed to evaluate whether critical components can survive the launch and the space environment. The fiber switch underwent vibration and shock testing and passed successfully. Additionally, the device experienced a thermal-vacuum test in which the setup was connected electrically and optically to equipment outside the chamber to verify the system performance during testing. Overall, eight cycles between -25°C and 60°C were performed. Performance was measured at extreme temperatures, without exhibiting any malfunctions in this case as well.

What's Next?

The payload returned to Earth on August 27, 2019 via Space-X 18. Since then, further investigation has been performed at OHB, mainly focused on the improvement of the stepper motor chain and high vacuum lubricants for a more accurate acquisition and calibration position repeatability. Furthermore, the fiber switch assembly, including the electronic board, will be assessed versus the radiation environment to determine the degradation of the optical components (e.g., fibers) and the suitability of the electronic parts.

The next step will be the development of a customized version with 1x55 channels to be used for the Exobiology Facility.

Optical Switches in Automated Test Systems

Fiber optical switches are well established in telecommunications, but they are also increasingly used in optical metrology, especially when several measurements are carried out in parallel. In many applications not every single sensor is equipped with its own evaluation unit to save space and costs. Fiber optical switches distribute the signals from several fiber-optic cables so that they may be evaluated one after the other. All-optical switches allow for fast and efficient data transmission without the use of fragile mechanical components.

LASER COMPONENTS offers a large selection of ready-made fiber optic cables as well as high-performance optical switches for your metrology application.

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