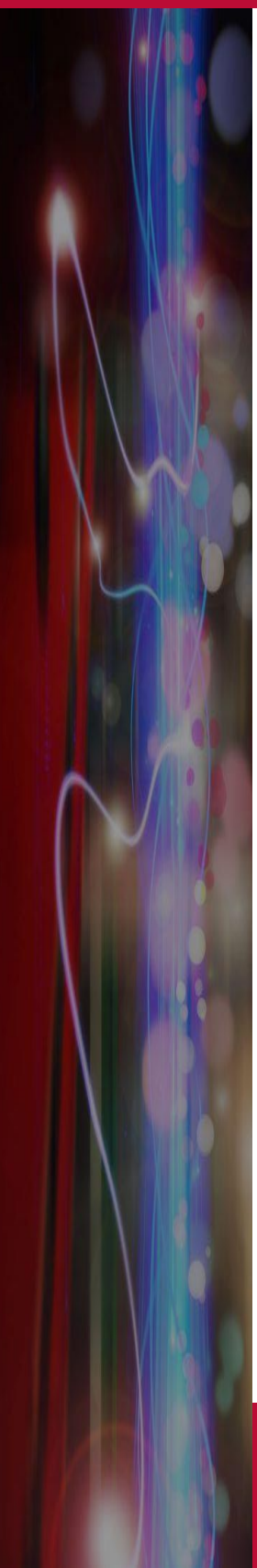
CASE STUDY

VCSELS FOR SATELLITE APPLICATIONS



The Customer's Challenge

Satellite technology has been improving rapidly in recent years leading to a need for higher bandwidth interconnects for data transfer between on-board subsystems. Traditionally, these interconnects have been copper cables, as they are known to be rugged enough to meet the harsh conditions of the launch environment and reliable enough to be deployed in a satellite applications. However, as the bandwidth required by the subsystems has increased, the copper cables have required more and more shielding to prevent signal integrity degradation and electromagnetic interference (EMI) issues, which increases the weight of the cable harness. Because the weight of a satellite is so critical for launch, the increased weight of the interconnect directly results in a reduction in available payload mass, so finding a method to reduce the mass of the interconnects without sacrificing the bandwidth or reliability was the primary goal of the prime contractor and their sub-contractor.

The Design Solution

Optical interconnects were an attractive solution for the satellite application because they have the potential to reduce the weight of the interconnects by more than 70% while still providing plenty of bandwidth. Plus, fiber has the added benefit of being immune to EMI, which is a concern on a satellite with a diverse array of sensitive subsystems in very close proximity. However, finding the opto-electronic components that had the design characteristics to be space-qualified proved to be a challenge for the prime contractor. Inneos' wide-temperature vertical-cavity surface-emitting laser (VCSEL) technology, which had been developed specifically for harsh-environment aerospace applications, offered an ideal solution.

The Inneos family of VCSELs are multimode VCSELs supporting wavelengths from 850nm to 1000nm at data rates up to 14 Gbps. Inneos has in-house design,

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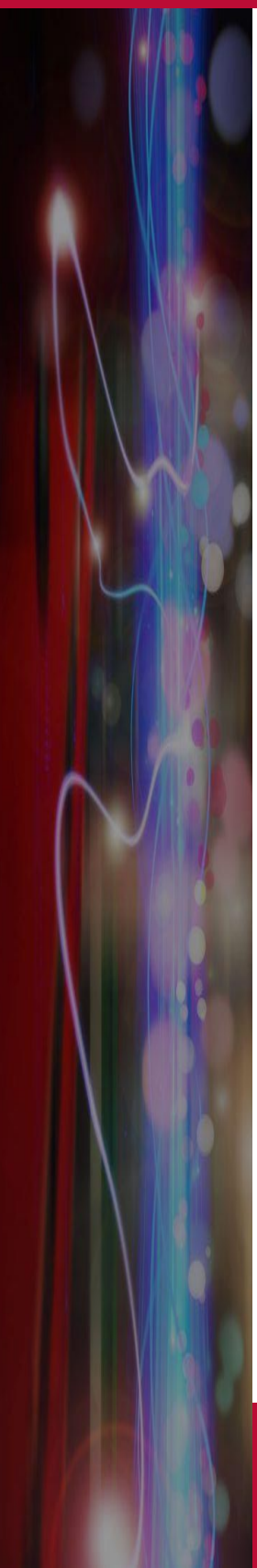

fabrication, and test facilities, all located in the USA, which was important for this particular program. Having the design, fab, and test in-house also enabled the design turn-around times to be fast, and all testing and quality controls could be closely monitored by the design team, sub-contractor, and prime contractor, as required for this type of program. Inneos has been designing, developing, and testing VCSELs for harsh environment applications for over 20 years, with many programs targeting aerospace and defense applications, so Inneos' project team was experienced in working within the structured development and qualification program requirements of the prime contractor.

To meet the requirements for the satellite program, Inneos performed a full space-level test and qualification program for a 995nm VCSEL supporting 2.5 Gbps data rates over a temperature range of -55°C to +125°C. This operating temperature range far exceeded the capability of standard 850nm commercial and industrial VCSELs, and was necessary due to the thermal vacuum environment of the satellite, as heat transfer is a much more challenging problem without air circulation. In addition to the higher operating temperature range, the reliability of the VCSELs needed to significantly higher than a standard commercial component, as replacement of a failed transceiver was not an option.

The Results

Inneos performed a thorough design verification test and qualification program for these VCSELs in order to fully characterize the corner-case operating conditions, to verify the performance of the VCSELs in radiation environments, and to establish the activation energies and determine a robust model for the VCSEL lifetimes. The reliability data of these devices at the standard operating conditions show a mean time to failure of nearly 10,000 years, far exceeding the expected operating lifetime of the satellite. Inneos' VCSELs successfully completed qualification testing for the satellite program, including radiation testing, wide-temperature device performance, and reliability testing, providing a key component enabling optical interconnects for satellite applications.

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