Electronic pressure regulator for fuel tank pressurisation in a Moon Lander

Aerospace is currently being transformed into an industry in which the barriers to access, such as high development costs coupled with a high risk of obsolescence, are to be minimised. The aim of this new space era is to make space travel viable for mass participation. Our project partner, the ArianeGroup, is a leading global corporation in the space transportation sector and it serves the needs of institutional as well as commercial customers. One of the things currently being developed by the ArianeGroup is the propulsion system for a Moon Landing Module which will be used in unmanned Moon landings to conduct research.

The initial situation

Due to the extreme nature of stresses and strains encountered in space travel, products are subject to exceptionally high quality and safety requirements. Until now, the aerospace sector developed individual solutions for every single mission, an approach that provides very little flexibility. The outcome was that every project entailed high costs and vast expenditure on development work. The aim of the New Space approach is to introduce new and reproducible kinds of solution with the aim of making space travel more accessible. To achieve this, those involved are trying to leverage potential synergies with other sectors such as the automotive or aviation sector and to make use of existing expertise in industrialisation.

The challenge

The Ariane Group therefore approached us with the challenge of developing a more flexible solution for regulating pressure in the fuel supply to a Moon Lander Landing Module for a transportation mission to the Moon.

“The core problem that VENTREX is trying to resolve for us, is to achieve greater flexibility in the pressurisation of the fuel tank, something that until now has been implemented in a very costly, one-off way for every single mission.”

Timo Krone, Senior Program Manager Advanced Programs, ArianeGroup
As a pioneer, and now as market leader in the development and series production of electronic pressure regulators for the automotive industry, VENTREX can look back on more than 10 years of experience and expertise as a series supplier. This qualifies VENTREX as the perfect project partner. Due to the ultimate requirements on quality, safety and efficiency of products in the automotive industry, the processes and systems used at VENTREX meet the highest standards of quality.

In this project, the clear stipulation from Ariane Group was that the solution devised by VENTREX should be as closely related as possible to its automotive volume production counterpart. The solution created should be a careful modification of the series product and should retained the core function groups. This enables Ariane Group to leverage existing quality data and the experience gained in the automotive sector. Which in turn means that risks relating to the functionality and safety of the project remain minimal and easily manageable.

**The way to the solution**

“In every new project, we take the time to listen carefully, and to devise customer–specific solutions. We want to develop valve technology solutions that exceed the expectations of our customers. At the development stage, we focus on reducing the complexity of the complete system to alleviate the problems faced by our customers. The goal is to design solutions that make the complete systems more efficient.”

Patrick Pfeifer, Head of Sales, VENTREX Automotive

The biggest challenge facing the project team was the tight time frame of 15 weeks from project start to shipping the first fully functional prototype. Close communication with the customer across all phases of the project and agile project management made it possible for the project team to tackle the project efficiently and to make rapid progress. To implement the requirements of the Ariane Group fully during this development work, it was quite literally necessary to leave the proverbial comfort zone behind. The successful and results-oriented work conducted by the VENTREX development department also included making mistakes, identifying those as mistakes and learning from them as rapidly as possible.

“At every stage of the design process, compliance with the specification was top priority, to create an optimum solution for the customer’s system. Our iterative approach to the development process helped us to identify wrong turns in the road at an early stage, and to eliminate them as a source of problems”.

Andreas Fuchs, Chief Technical Officer, VENTREX Automotive

Much like its series production counterpart, this electronic pressure regulator for use in space is based on a 2-stage concept. The mechanical pressure stage for pre-regulation and the electronic pressure stage for precision regulation were adapted in parallel fashion to suit the requirements of the Ariane Group.

Within just a few weeks, the material compatibility of lubricants was tested to contend with the more demanding requirements of outer space and its vacuum environment. For evaluation purposes, the project team developed functional testing facilities in a vacuum environment with adjustable ambient temperatures. Seal integrity, permeation and strength were calculated digitally using ANSYS simulation software.
Within a very short period, the rapid prototyping approach led to realistic design templates that could be used to detect potential defects in the design process at an early stage. Different materials were evaluated and tested to determine their viability for operation in space.

The medium, helium 5.0, more stringent vibration-related requirements, a 20% increase in operating pressure, a mass throughput increased by 65% and a bursting pressure stipulation of 775 bar make the development of potential solutions for electronic pressure regulators in the aerospace sector a challenging task.

The solution

The expertise and personal commitment of the project team made it possible to create a requirements compliant functional prototype for further testing within just 15 weeks.

Since the solution they developed is close to the series product, retaining the core function groups, the new pressure regulator was able to inherit much quality-related experience. The central elements of the solution have already been in serial production for the last 11 years, satisfying very stringent requirements in relation to efficiency, safety and consistent quality. This close connection between the New Space pressure regulator and its series production counterparts enable the ArianeGroup to evaluate and estimate risks very well. Another advantage is that costs are much lower than of solutions previously used in landing modules.

The ‘New Space’ pressure regulator from VENTREX equips the landing module with a high level of flexibility in relation to fuel supply, achieved through the ability to control fuel flow electronically. The developed valve technology solution definitely has the ‘disruptive potential’ of replacing the inflexible mechanical components used so far, while also providing the potential for further and more extensive applications.