Radiator Testing in Simulated Space Vacuum Conditions

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Category:
Automated Test

Products Used:
LabVIEW 2012
PCI-6225
SCXI-1001
SCXI-1102
SCXI-1102
SCXI-1125

The Challenge

The user required a system that could be easily moved and connected to a number of test systems, and allow the live viewing of data from a remote testing position.

The Solution

The National Instruments platform provided the channel count and signal conditioning needs of the customer and allowed the flexibility of deployment required by a fast-paced research lab.

Introduction

Data Science Automation (DSA) is a premier National Instruments (NI) Alliance Partner that specializes in automating and educating the world leading companies. Clients choose DSA because of DSA's deep knowledge of National Instruments products, disciplined process of developing adaptive project solutions, staff of skilled Certified LabVIEW Architects and Certified Professional Instructors, and unique focus on empowerment through education and co-development.

Approach

NI LabVIEW was integrated with high accuracy signal conditioning hardware in order to monitor radiator cooling in a vacuum environment. Live display and recording of the data allowed proper management of an expensive test. Matching and confirmation of infrared derived data was made during analysis. The users could rapidly deploy separate tests due to the portable nature of the systems and had the ability to adjust the system to different hardware sets using the custom Scales in NI MAX (Measurement and Automation Explorer).

Background

The conditions experienced in space are both harsh and difficult to replicate on the earth's surface. Space-based systems are complex and generally incorporate both solar and radiator panels (Figure 1). The needs of near perfection in space flight require a rigor of testing to as closely as possible approach 100% dependable systems. One of the tools used to test space bound equipment are the Thermal Vacuum Testing chambers (Figure 2) at our customer's site. These chambers enable the vacuum and freezing conditions of space to be replicated in a lab environment in order to test everything from propulsion systems to solar panels and radiators. Our task was to allow the testing of these systems to be monitored and recorded with ease, accuracy, and reliability.

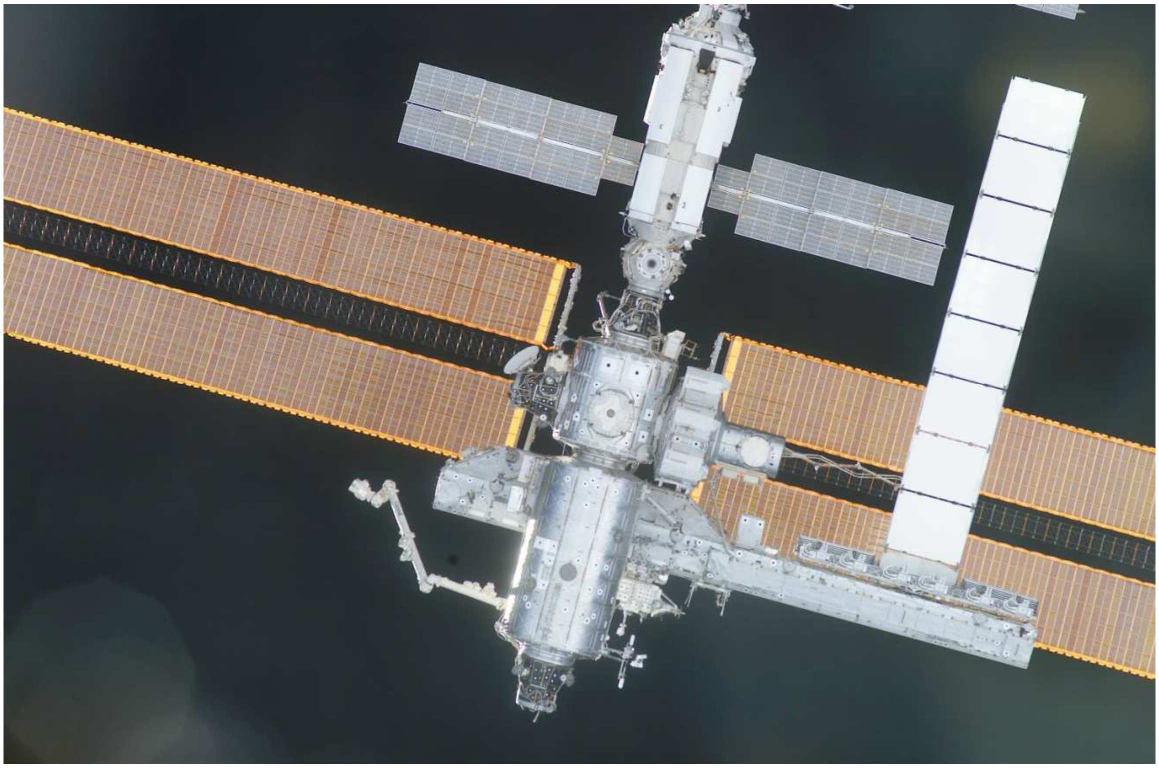

Figure 1. Satellites contain both solar power panels and radiator panels

Figure 2. Thermal Vacuum Testing Chamber

The device under test in this system was a thermal radiator, which used heated oil to maintain the temperature of space-based systems. Normal heat-sink problems are exacerbated in space, as the lack of atmosphere makes conductive or convective cooling negligible.

Therefore, we instrumented a thermal radiator so that its surface temperature profile could be readily monitored while in the test chamber. Due to such low heat transfer and small heat differentials in place, the high accuracy SCXI-1102 thermocouple module was a valuable piece of hardware. The built in signal conditioning and the ready scalability were benefits to the research environment where the device under test and testing hardware are under constant change and improvement.

During the test, the users had an infrared image of the surface and wanted to compare it to the precise temperatures gathered at the radiator surface by the thermocouple array. For the ease of comparison during tests, we incorporated digital images of the front and back surfaces of the radiator into the user interface, so that location-specific temperatures would be easily mapped to surface locations (Figure 3).

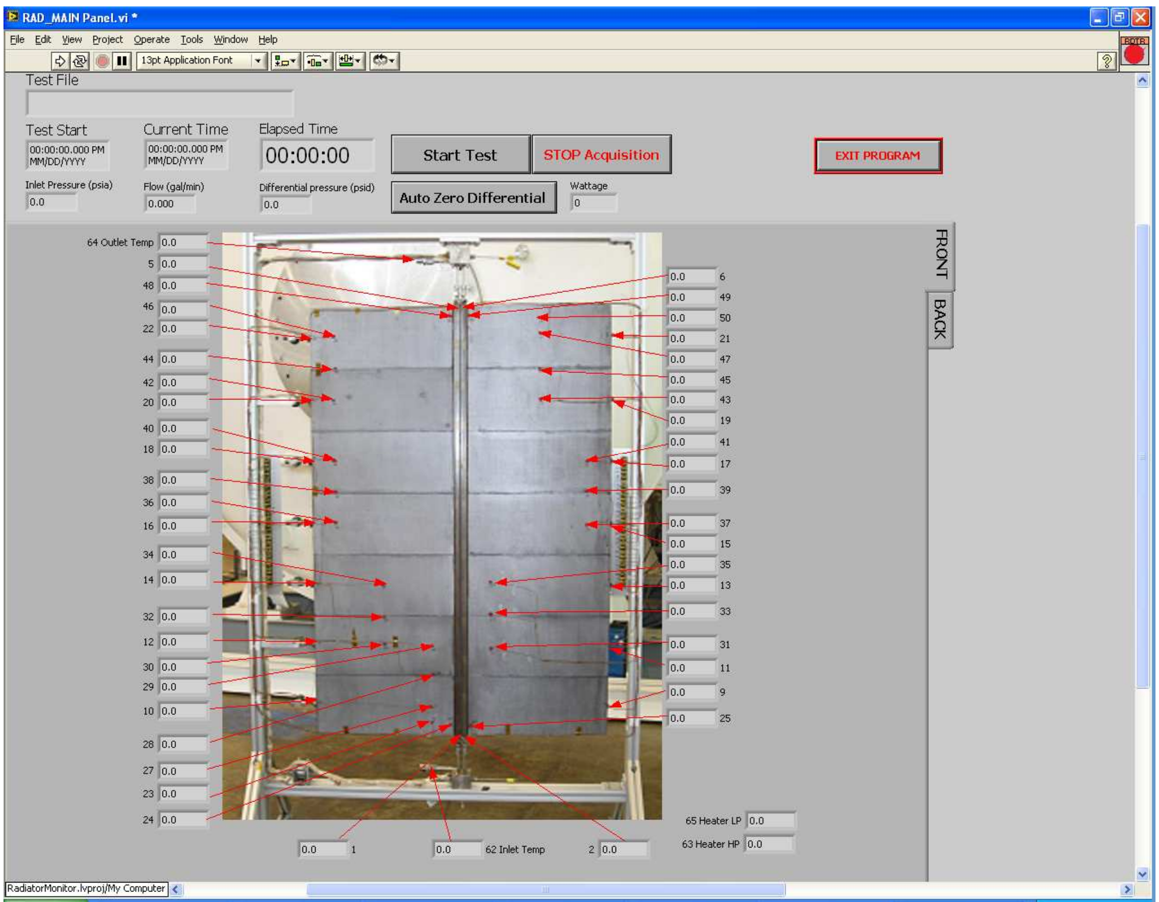

Figure 1. User interface, showing radiator surface (Front View)

All of the displayed values were also recorded so that they could be played back at a later date. Several other values, such as the pump flow rate and oil inlet and outlet temperatures allowed a calculation of the total heat lost by the system.

The system was designed to be inherently flexible and the user interface allowed the researchers to assign the channels to whichever location they needed the system to record. Similarly, the scaling factors for the oil flow and other sensors were adjustable in the NI MAX custom scales, which allowed user-editable replacement of the transducers as the experiment was refined.

The facility was in high demand, so the ability to quickly install and set up this experiment enabled more efficient utilization of a valuable resource, the vacuum chamber. This speed allowed more total tests, which added value to the busy facility.

Conclusion

The end result was a system that enhanced the legacy measurement methods and provided superior test monitoring and data recording. This allowed iterative improvements and testing of the radiator as the project progressed. Future development may serve to use NI DIAdem to integrate the live data acquisition with the infrared images for a combined data playback, plotting alongside total heat transfer data.

Contact Information

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