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Space Simulator Chamber
using the TempScan™

Space Exploration

Application Note #68

Application Summary

Satellites, probes, and vehicles designed for space travel face widely fluctuating temperature extremes, from about -259˚ to 200˚C. All are thoroughly tested before deployment to ensure onboard instrumentation and components can withstand such a rigorous environment. The Space Dynamics Laboratory, part of Utah State University's Research Foundation, is one of several institutions that for many years has been awarded contracts from NASA, the Naval Research Laboratories, other agencies, and prime contractors to design, test, and prepare hardware for space travel and exploration. To support their efforts, the Space Dynamics Laboratory has designed and built several space simulator chambers specifically for temperature and vacuum testing of flight hardware prior to launching them into space.

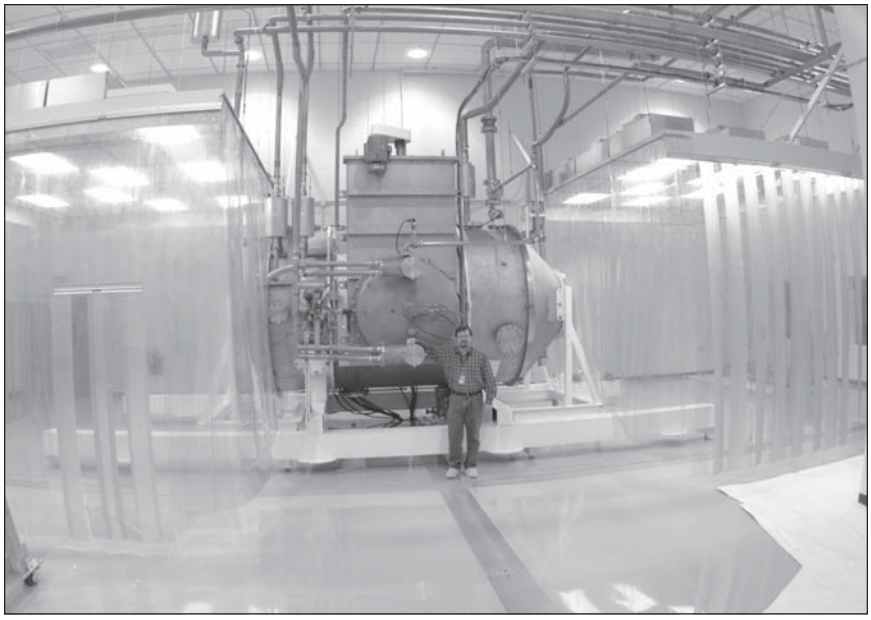
A data acquisition system and a control computer are among the primary test instruments used in the lab for this purpose. They automatically measure a large array of temperature sensors in the space simulator chamber to ensure that temperatures are maintained within specific parameters. RTD sensors in the shroud surrounding the 16 ft. long by 9 ft. diameter chamber number about 124. All test hardware used in the lab must meet the highest standards of performance and durability. They also must be exceptionally reliable, easy to connect and program, and run automatically.

Potential Solution

Stephen Dansie, Engineer Associate at USU's Space Dynamics Laboratory, had used a large number of well known computer plug-in boards for several years to gather test data in the space simulator chamber. But they are difficult to connect and require an intermediate RTD interface chassis with bothersome cables that fan out to 20 zones of sensors. Says Dansie, "They were a bit awkward to use and difficult to connect — simply inconvenient. Also, the instruction manuals left a lot to be desired."

IOtech's Solution

When he was ready to purchase additional test gear for new chambers, Dansie selected IOtech's TempScan™ instruments. The TempRTD/16B™ RTD scanning modules eliminate the need for the intermediate RTD interface chassis, external signal conditioners, multiplexers, and custom cables. "For the aerospace industry," says Dansie, "we basically want high quality; we need the equipment to work right, and we depend upon it. So the lab is willing to pay extra for that kind of quality. Furthermore, when I spec out a piece of



The Space Simulation Chamber control station at USU's Space Dynamics Laboratory currently uses IOtech's TempScan instruments, Digital488/80A™ interfaces, and Exp/10A expansion chassis to test various spacecraft, satellites, and infrared telescopes for space or terrestrial observations. Scientists use the onboard cryogenically cooled instruments to observe distant galaxies, gas clouds, and stars, and obtain their infrared signatures. Other infrared telescopes look at the earth from space to observe the greenhouse gasses, the ocean-water temperatures, and other climatic conditions.

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equipment, functionality and reliability take precedence over price."

Dansie connects the TempScan to 80 channels of RTD sensors distributed on the space simulator's cryogenic shroud. The shroud contains both liquid-nitrogen cooling lines and heater cartridges to either heat or cool the chamber. During a typical test cycle, the chamber is first evacuated to a pressure of 1 x10^{-6} torr. The shroud is then heated, which raises the temperature of the instrument to just under 100˚C, a value determined by the test engineer. The heat helps drive off any water the in the chamber and accelerates the out-gassing of the overall system. Depending upon the instrument's program requirements, the time at bake-out temperatures may vary from two days to a week, sometimes longer.

In addition to monitoring the temperature of the cryogenic shroud and instrument platform, temperature sensors mounted on the vertical cryogenic lines (a part of the shroud) are also monitored. These temperature sensors are placed vertically on the cryogenic lines at equally spaced distances. By monitoring the temperature gradients that develop from the rise and fall of the liquid nitrogen inside, an indication of liquid nitrogen levels can be determined. The TempScan performs this task well.

All sensor signals are collected together into a series of five cables, one for each TempScan card, and pass through the chamber wall via a hermetic connector. The cable then snakes down, under the floor trays, and finally to the control room where the TempScan cards are located.

Dansie and his colleagues use LabVIEW® software, which is integrated into the whole system. This includes the temperature monitoring and control hardware and all instruments. All data funnels to one rack-mounted computer for analysis. Previously, Dansie used a well-known workstation with an IEEE-488 card, but now the power of the PC is on par with the older workstation and it gives him more flexibility.

Says Dansie, "The IOtech TempScan is highly regarded in the lab, not because it is so much different than other test equipment, but that it just works so well." There are a lot of ways to read RTDs and to control equipment, but Dansie depends on the IEEE-488 communications protocol for most of the instrumentation and controls. The TempScan allows easy integration into his software systems.

Conclusion

Utah State University's Space Dynamics Laboratory houses a space simulation chamber for temperature testing, baking, and out-gassing a variety of space-bound components, including satellites and IR telescopes. The main data acquisition instruments comprise IOtech TempScan instruments and Digital488/80A™ (IEEE-488) interfaces connected to a rack-mounted control PC. The TempScan instruments let test engineers monitor temperatures in the chamber from cryogenic levels, about -200˚C, to higher temperatures used in bake-out conditions up to 100˚C. The temperature sensors mounted on several vertically running cryogen supply lines located on the shroud also indicate coolant level by measuring temperature gradients.

TempScan

The TempScan is well suited for temperature and lower-voltage measurement because its solid state scanning provides temperature readings at speeds up to 960 channels/s, an important feature in applications that require monitoring of tens or hundreds of channels. The TempScan includes ChartView™, one of IOtech's *Out-of-the-Box™,* Windows®-based setup and acquisition applications. ChartView provides a graphical spreadsheet-style user interface that lets you easily configure your hardware, acquisition, and display parameters. Compatible with all versions of Windows®, ChartView features a no-programming approach that enables data collection and display within minutes of taking your TempScan *Out-of-the-Box™*.

Features

- Measures thermocouples, volts, and RTDs at up to 960 channels/s
- Accepts optional scanning modules for measuring thermocouples, RTDs, or DC volts
- Expandable up to 992 channels
- IEEE 488 and RS-232/422 interfaces
- Ethernet communication with optional Net232
- 32 TTL digital alarm outputs and 8 TTL-compatible digital inputs
- Custom thermocouple types for user-defined linearization tables
- Two programmable scan rates for:
  - pre-trigger & post-trigger sampling
  - accelerated sampling on-event detection
- 128 Kreadings of memory, expandable up to 4 Mreadings
- Built-in real-time clock:
  - synchronizes acquisition to time of day
  - provides time and date stamping for trend monitoring

Software

- ChartView™, an *Out-of-the-Box™* data logging application for effortless setup, acquisition, and real-time display
- eZ-PostView™ included free with *Out-of-the-Box™* application software
- ScanCal™, calibration software
- Citect SCADA/HMI software with dedicated TempScan and MultiScan drivers

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