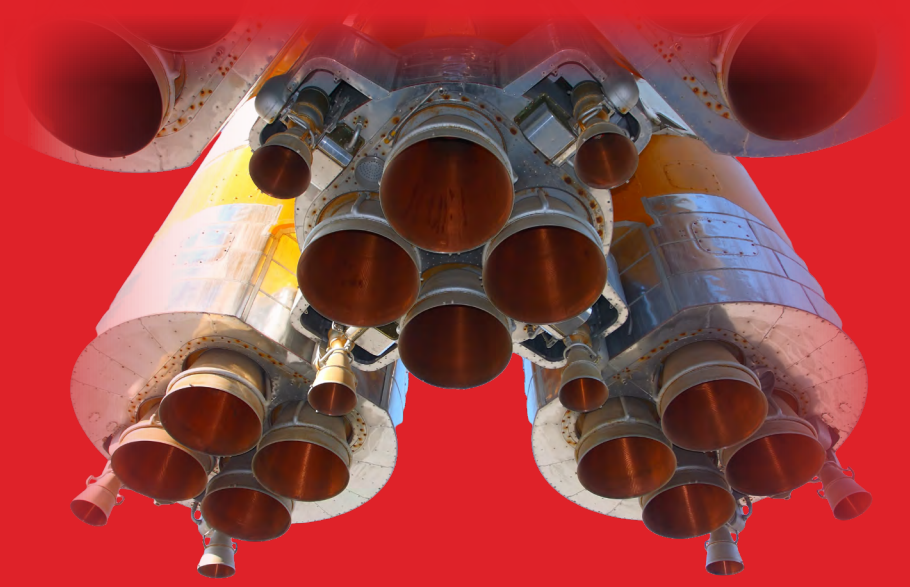
APPLICATION NOTES



Temperature Control for **Vacuum Chamber Testing in Aerospace & Defense**

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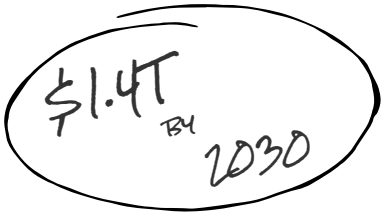
Soaring Growth Anticipated for Aerospace & Defense Industries



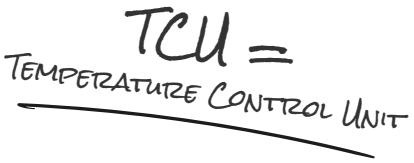
Some economic forecasts predict that the space industry will triple to $1.4T by 2030. Historically, government agencies have been at the helm of growth and innovation. Now more private companies, start-ups, small-to-midsize companies, large corporations, and emerging countries are joining the space race.

Space travel and tourism may dominate the headlines, but that isn't the only factor driving the astronomical growth. Advances in technology depend on our ability to increase the performance of satellites, broadband, and bandwidth communication technologies. Small, lightweight, even miniature satellites, also known as CubeSats, are in high demand for many applications. Much of our modern science and technology depends on products that can survive the extreme temperatures and harsh environment of space.

Some of the applications driving industry growth:

- Earth and space observation
- Climate monitoring & data collection
- Security and missile defense
- Earth mapping
- Internet access
- IoT (internet of things) communication
- GPS, logistics, and fleet management
- Missile & military defense

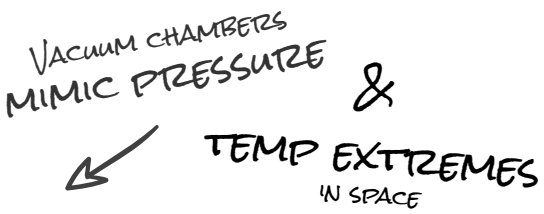
Finding Reliable Resources for High-Altitude Temperature Control



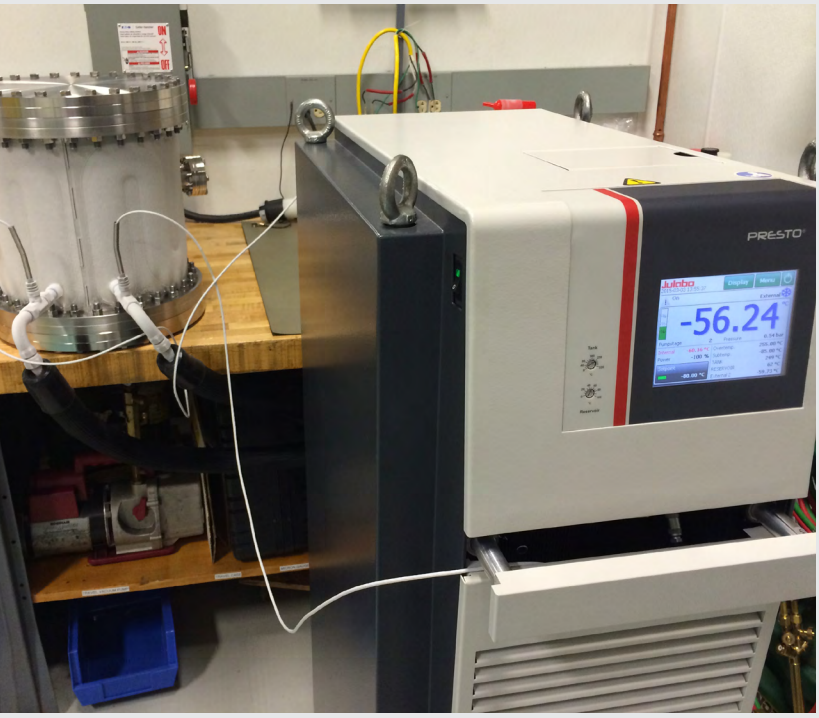
With more companies entering the field and more products in development, the need for testing equipment, including environmental simulations in a vacuum chamber and auxiliary temperature control units, will also increase. There are many ways to control temperatures during environmental tests. Knowing how to size a temperature control unit (TCU) for various vacuum chambers requires expert consultation and support.

This application note will explore how a temperature control unit (TCU) supports vacuum chamber testing and what to look for in a temperature control unit. Note, we use the more general term, TCU or temperature control unit, which includes circulators, recirculating chillers, heaters, temperature controllers, or temperature control systems. TCU in this context refers to equipment that circulates a thermal bath fluid through a closed-loop system to heat or cool a specific object.

The Importance of Vacuum Chamber Testing



Space components and systems are tested in a thermal vacuum chamber, where variables such as pressure and temperature can be controlled and adjusted. The chamber mimics specific space conditions under vacuum to ensure components and systems can survive the unique pressure and temperature extremes they'll experience. This is a critical part of development since there is no room for error once a system is in orbit. Servicing a broken component in orbit is not a viable option, though the Hubble Space Telescope has had some success. For most manufacturers, repairs in space remain extremely expensive and challenging, if not impossible.



Controlling & Testing Temperatures in the Vacuum Chamber

Vacuum chambers come in various sizes and configurations, from large spacecraft-sized chambers to small benchtop units for CubeSats and material/component testing. Typically, a platen (or paten) inside the vacuum chamber houses the material or components for testing. The platen incorporates a cooling coil that connects to an auxiliary TCU (such as recirculating chiller) through a manifold in the chamber wall. After pulling the desired vacuum, the TCU cools the platen by circulating a refrigerated fluid, and testing continues. Some vacuum chambers also incorporate cooling channels on the chamber walls, also known as the shroud. Depending upon the size of the chamber and desired temperatures, this might require separate TCUs for the platen and chamber.

Note: *Those looking to replicate cryogenic temperatures, and those with an LN2 application or facility, may use liquified gases such as liquid nitrogen to cool the vacuum chamber. This temperature method allows users to replicate deep temperatures, however, it is difficult to control the target temperature and comes with various safety concerns, including noise and the release of potential asphyxiants. Again, there are several ways to heat, cool and cycle through temperature tests within a vacuum chamber. An expert temperature control consultation can help you determine the best method based on your goals and parameters.*

Free consult with JULABO

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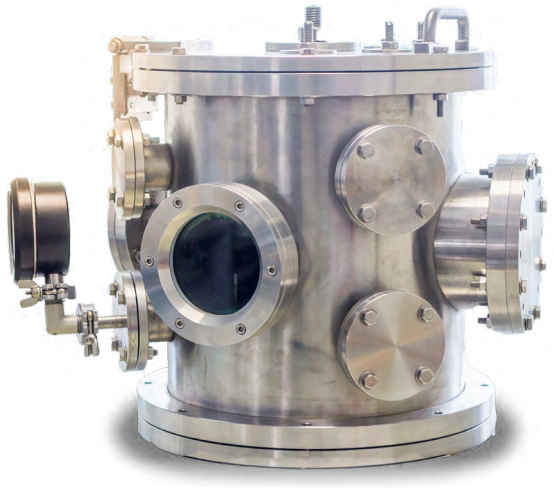
Temperature Applications, Challenges & Considerations



When specifying a temperature control system or TCU for vacuum chambers, several factors come into play.

1. **For platen-only applications:** the mass and material of the platen, desired temperature or temperature range, application mass, and any known heat load will dictate the selection of a suitable TCU. Since the application testing occurs under vacuum, the system will not have any heat loss to the atmosphere.

Platen mass + desired temperature + application mass + known heat load = appropriate TCU

2. **For platen and chamber wall (shroud) applications:** information for the platen (as in #1) plus the mass and desired temperature of the chamber wall will determine the need for one or two TCUs. For the best results, you'll also want to insulate the exterior of the chamber walls.

3. **Additionally,** you'll want to consider whether your facility or application restricts the use of certain thermal fluids, such as silicones. The TCU uses a closed-loop system to circulate thermal bath fluids that heat and cool chamber components. Silicone bath fluids are popular choices for low-temperature applications, but silicone residue can contaminate fabrication/assembly facilities. Hydrofluoroether (HFE) fluid is a great alternative that doesn't leave a residue and provides excellent low-temperature heat transfer. Before specifying a TCU, check the bath fluid requirements and options.

Look for TCUs that use Hydrofluoroether (HFE) fluid, which are great for low temperatures and won't leave a residue.

4. **Finally,** you'll want to think through how you'll be integrating the temperature control unit into your application. Will you need testing thermocouples for remote temperature control and monitoring? Will you control the test parameters with an external computer or PLC control? What are your data capture requirements, and what temperature variables do you want to track? You'll want to look for a TCU with input/output communication controls that work best with your workflow.

I/O Input/Output communications are often the key to enhancing workflows.

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PRESTO TCUs

-92°C TO +250°C

Temperature Control Units for Vacuum Chamber Tests

Many aerospace and defense manufacturers rely on PRESTO temperature control systems from JULABO USA, which are ideal for most vacuum chamber testing. They provide a wide range of working temperatures, from -92˚C...+250˚C, with the capacity to meet various vacuum chamber test requirements. The PRESTO units employ the cold-oil overlay technique, which eliminates atmospheric moisture condensation in the bath fluid during low-temperature operation and can function with HFE fluids. In addition, PRESTOs incorporate a variety of communication options for integration into computer control systems. A thermocouple adapter accessory is also available.

To learn more about the PRESTO product line, please visit the **JULABO USA site** or download the overview **PRESTO Performance Advantages Explained**.

JULABO USA also offers several ultra-low refrigerated circulators for customers looking for additional options. Some of our aerospace and defense partners use multiple recirculating chillers to quickly cycle between high and low temperatures. Our team can help you determine which TCUs are best for your project and budget.

Expert Consultation for TCU Recommendations

With so many applications, configurations, and temperature extremes, TCU requirements vary significantly from one company to the next. Our technical experts, including our application scientist, work directly with your team and engineers to ensure you have the temperature control unit or system you need to run your application efficiently and effectively.

Additionally, the JULABO USA App allows you to access our complete product portfolio and narrow down your options based on specific parameters and calculations. You can also compare up to four products for initial product explorations. However, we recommend speaking to our team before making a final selection. With the mobile location service activated on the app, you can access your local account manager's contact information under the "Sales" tab. Your account manager, along with our in-house team of experts, will ensure you get the temperature control unit or units you need to ensure safety and success.

Visit www.JULABO.us for more recommendations!

PRESTO A80

PRESTO A85

PRESTO W91

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Conclusion & Next Steps

As space exploration, high-altitude communications, and defense technologies accelerate, the need for expert temperature control testing and environmental simulations will also rise. JULABO USA has in-depth experience consulting with the biggest names in aerospace and defense. We'd love to tell you who they are, but their secrets are safe with us. So whether you're a leading force for space exploration or a new start-up enterprise, we have the experience to propel your testing forward with ease and confidence.

Contact us directly

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