How to Choose

Connectors for Space

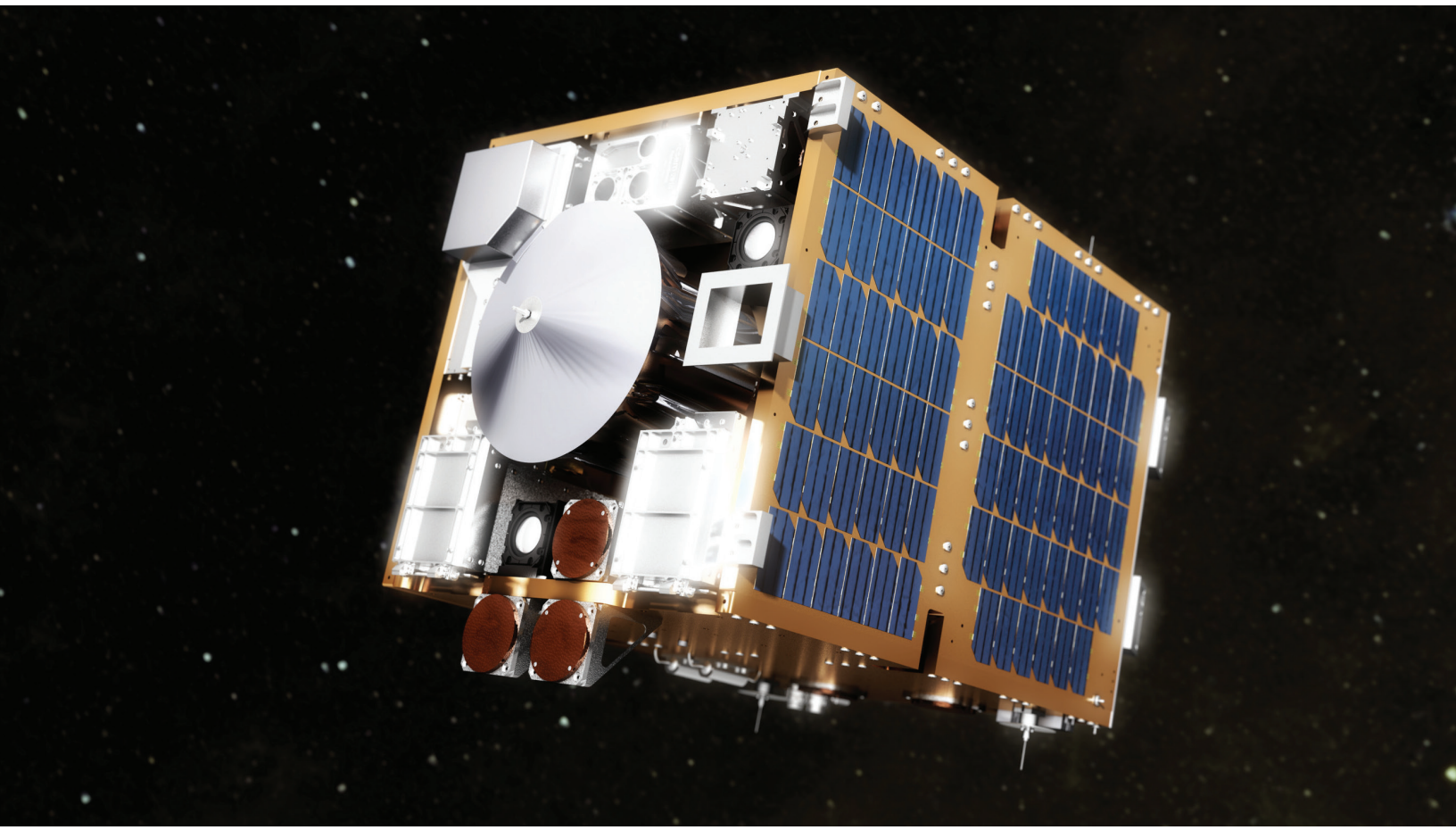
There are many demanding applications on Earth, and many high-reliability connectors exist that will do a fine job performing in those environments. But space brings a few additional tricky problems, and a little extra planning is needed to make sure these are factored in to the connector choice.

Considerations:

- Vacuum
- Cosmic and thermal radiation
- Cost of pushing mass away from the Earth's gravity
- Space (volume) allowance in a rocket
- Vibration at launch
- Cost of failure and repair

Before we look at each of these issues in detail, we first need to define a key phrase in that first sentence. If you work in the space industry, your definition of "high-reliability" may be slightly different from how we use it in the connector industry. Often, the space version of high-reliability means mission-critical and involving risk to human life. Devices that are not quite so critical will be labelled "commercial". For the connector industry, any application that subjects the connector to vibration or temperature variations requires a "high-reliability" connector.

Photo: Surrey Satellite Technology Ltd and Surrey Space Centre



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Can I just specify space approved connectors?

You could specify space-approved connectors everywhere on your build – but this comes with a technology and cost penalty. Typically, space qualification of an electronic device is an incredibly lengthy process and can take several years to achieve. This has resulted in a list of qualified components that are old technology – it's just not possible for the long process to keep up with the pace of development. It's also an expensive qualification process, and this will be reflected in the final price of the products.

Specifying from the approved list will mean older, heavier, larger and more expensive components are your only choices. Companies in the CubeSat industry (as an example) are free to innovate and pursue the best & latest technologies available, not restricted by the requirements of space approval.

Let's consider each of the challenges listed earlier, and some aspects to consider in your connector choices.

Vacuum or partial vacuum

The lack of air affects the maximum voltage rating of a connector – the moment of flashover from a conductor to the nearest metal item. Flashover will occur at a different voltage depending on the density of the air molecules, so look out for connectors that have a voltage rating for altitude.

Then there is outgassing, or offgassing. This is not specific to electronics – it's an effect that occurs in all materials, and is the release of gas dissolved, trapped, frozen, or absorbed. Causes can be sublimation and evaporation (phase transitions of a substance into a gas), desorption, seepage from cracks or internal gaps, and gaseous products of slow chemical reactions. This introduces contaminants into the equipment, which might cause problems at any time during the life of the product.

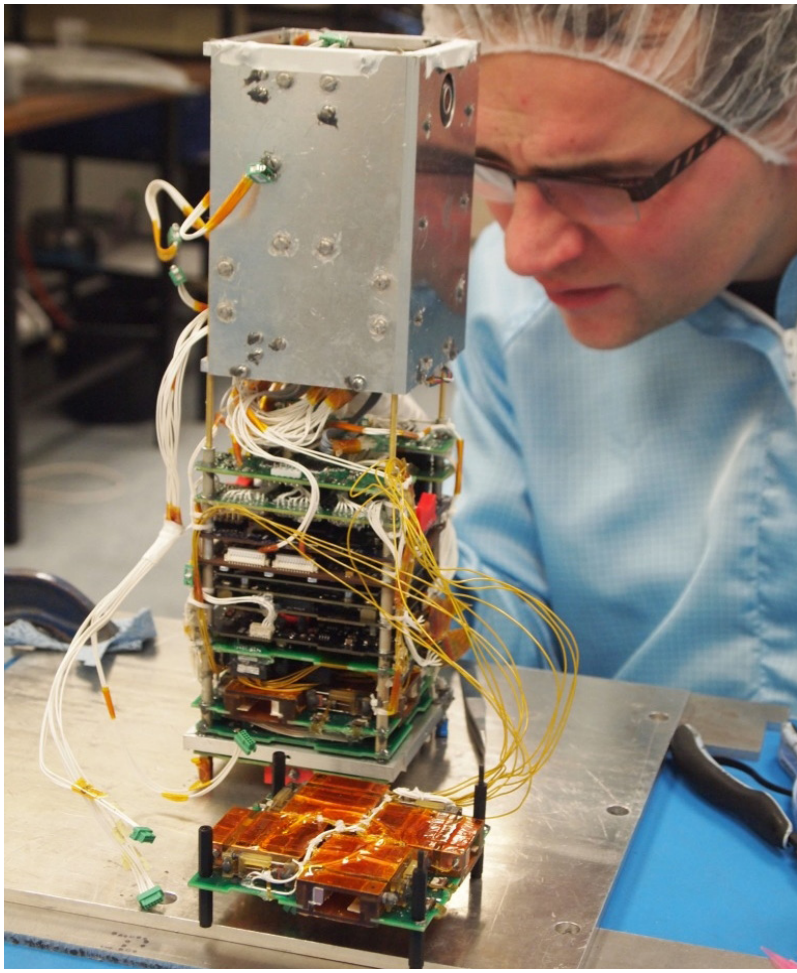

Photo: Surrey Space Centre

Both NASA and ESA (the European Space Agency) specify recommended volume levels of outgassing for materials used in their space applications, so check with the manufacturer if their materials meet these levels.

Cosmic and thermal radiation

Cosmic radiation is a problem as you increase altitude and our protective atmosphere thins. The levels are detectable even in normal air travel, so in partial vacuum it is a significant issue. The effects are like EMI in ground-level electronics – and the solution is the same: shielding. The metal case of the space vehicle will provide some protection but added shielding on vulnerable PCBs or cables should also be considered.

Thermal radiation increases when your space vehicle is in direct sunlight with no atmosphere – but the temperature can also drop to very low levels in shadow, or even on the side of the vehicle away from the sun. If your satellite has its own rotation, there will be constant thermal cycling of the outermost layers. This is less of an issue if the electronics are buried deep into the center of the vehicle, as the direct thermal effects are much lower. But with a CubeSat measuring just 10cm across, thermal cycling of all components is a concern.

Check the connector specifications for max and min temperature range during operation (not just soldering heat resistance). Look for additional testing for thermal soak (sometimes listed as high temperature, long term or temperature life) and thermal cycling.

The Cost of Weight, the Cost of Volume

Every gram pushed into space from the Earth's surface costs money. More mass equals a bigger vehicle. The bigger your vehicle, the more room you have. However, the more fuel you need to be able to carry. Both volume and weight carry penalties – and rockets & rocket fuel are not cheap. So, you need small and light. Every gram saved on a connector is a gram that can be spent on the payload.

Look for connectors in the performance bracket you need that are also the smallest and lightest possible. Don't over-specify where you don't need to. This is especially true in the CubeSat market. These are miniature satellites designed to be multi-stacked in a rocket, and both space and weight are at a high premium. But longevity and human life are not factors, so the cost of failure is much lower than a manned vehicle.

Stress at Lift-off

Launch is a high vibration, high acceleration environment. Your connections need to be able to survive this period intact and still mated, so they can be ready to perform once floating in orbit. Make sure your connectors are rated for vibration, shock and acceleration. Specify jackscrews or latching where possible.

Cost of Failure and Repair

Are you transporting astronauts and cosmonauts, space telescopes or the next Mars rover? As disappointing as a failure of your CubeSat might be, it's not going to cause loss of human life or a million-dollar setback (probably). Avoid over-specification and choose your budget wisely. Set your connector requirements based solely on your performance requirements, not paranoid "what-if" scenarios.

How can Harwin help?

We can help get the best from your design and budget by choosing connectors that meet your specifications. Our high-reliability connectors are as small and light as we can make them, whilst still delivering amazing current (power) levels for their size. Every feature on the product has a purpose, and the final design is cost-effective compared to industry standard alternatives.

Gecko-SL has been a firm favorite for the growing CubeSat industry since its launch. The compact size and very light weight are minimal for the performance achieved. The average weight of each connector is just 1 gram, including robust screw-loks to overcome any vibration issues. The plastic used meets NASA and ESA expectations.

CubeSats comprise of a dense stack of PCBS, so height above each PCB is limited. Gecko-SL now offers both horizontal connectors and mating cable assemblies to solve this challenge. By installing the horizontal connectors on the edge of the PCB, you can route the cables sideways round the stack edge, saving space above the PCB. The cables are ready-made and in stock, further reducing the upfront cost of your project.

See how we can help you with connectors and hardware for your space application.