Douglas Electrical Components

The Six Challenges Of Specifying And Procuring Hermetic Feedthroughs For Space Simulation

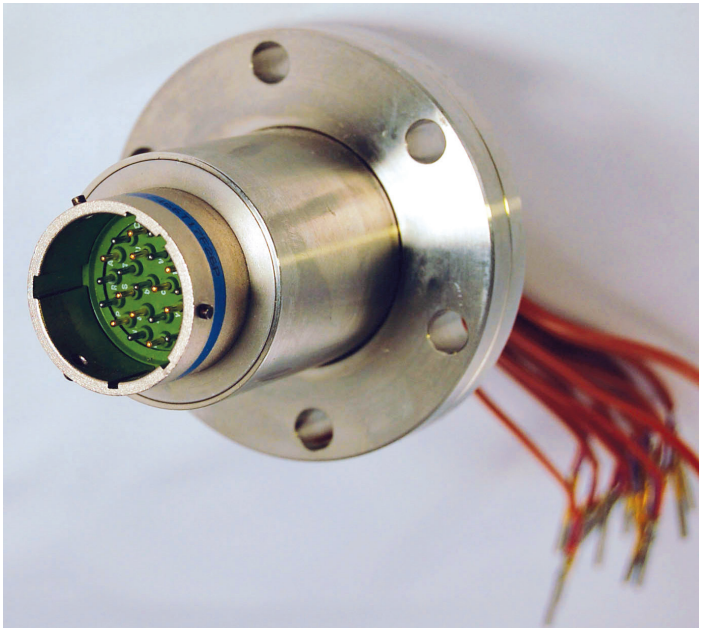
The purpose of this white paper is to share the details and knowledge that engineers at Douglas Electrical have gained over the years regarding the specification and sourcing of hermetic seals and feedthroughs used in space simulation vacuum chamber applications. Having worked with most major space simulation facilities over the years, it is our hope that by sharing these observations, vacuum chamber test engineers both experienced and inexperienced will have an easier time solving the typical problems that can occur in feedthrough applications.

From our experience, there are six major areas of concern that factor into the specification and procurement of hermetic feedthroughs. These include: signal loss; signal density; material selection; the need for highly customized solutions; retrofitting older vacuum chambers; and provisioning for bench testing. As I recently heard while at a NASA facility, in all of these challenges, "The devil is in the details." Let's start by looking at some of the "details" and concerns around signal loss.

FIGHTING SIGNAL LOSS

One of the major sources of frustration we have observed over the years is that of engineers battling signal loss due to poor connectors and/or poor choice of conductor material. A customer told us recently that "One of our primary concerns is to alleviate thermocouple read errors." After all, accurately measuring the results of thermal testing is a major aspect of most programs. In our experience, we have found faulty connectors to be the major source of signal loss. One solution is the use of continuous wire feedthroughs, which in some applications may perform better than those with connectors. However, if your application needs connectors on the bulkhead, don't skimp on your connector specifications. Milspec connectors and the use of thermocouple grade copper pins can help alleviate signal loss.

Another frequent contributor to signal loss is poor choice of conductor. Working with delicate controlled impedance wire can be a challenge,



Featuring continuous low impedance wire and thermocouple grade pins, this Conflat Thermocouple feedthrough was designed to fight signal loss in vacuum chamber test environments.

but may offer better results. Again, specifying thermocouple grade conductor material with special limits of error calibration at the outset of your project will help keep signal loss challenges to a minimum once you've pulled vacuum and entered test mode.

SIGNAL DENSITY CHALLENGES

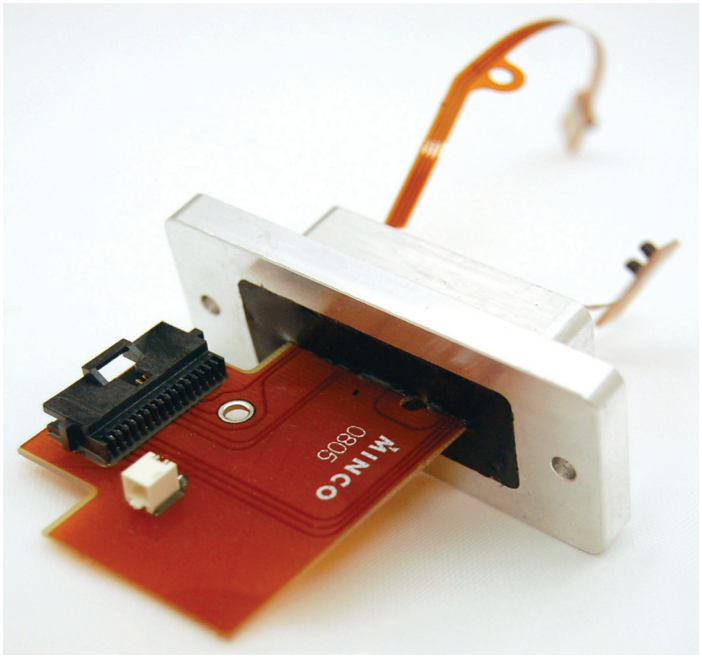
With more and more electronics in every flight test package, we find a continuing requirement to push more signals and more wires through existing openings. A typical challenge we recently faced was a need to pull 55 thermocouple wires through a 1 inch opening. Adding to the complexity was a variety of mounting geometry challenges. In this case, a potted solution with appropriate conductor selection provided both the required signal density as well as meeting the geometry of the application.

Pulling large thermocouple counts through small, existing apertures is a problem experienced by every facility, such as a recent project where we needed to fit 100 thermocouple pairs through a 1.75 inch opening. So don't panic if your next project seems to be asking the impossible when it comes to signal density. There are virtually no limits with the right choice of conductor and feedthrough configuration.

With the right choice of conductor material, feedthroughs like this one routinely route over 1,000 conductors.

MATERIAL SELECTION CHALLENGES

The extreme environmental conditions to which space equipment is exposed throughout its working life demands that the highest standards possible be met in terms of materials and system reliability.



Creative use of materials can solve many feedthrough challenges, such as this hybrid rigid/flex circuit board feedthrough.

A typical comment we hear from our space simulation customers is that "Everything is important in our supply chain." Compliance with standards is important. For example, our epoxy was recently approved by NASA as a low outgassing material. Depending on your facility and test program, standards can also include track and trace requirements right down to component level. Ensuring that your feedthrough supplier can trace to wire spools is an imperative. It almost goes without saying that domestic sourcing can make compliance with these types of requirements a lot easier. This is also something you need to deal with ahead of time, giving the suppliers ample time to source approved materials.

Performance standards and application requirements can also have a great bearing on material selection. We are seeing more and more fiber optic and hybrid fiber optic/copper configurations, both to handle signal density

demands as well as cut signal loss. Spend some time at the outset on material specification. There is a lot to choose from, and new materials are constantly being developed.

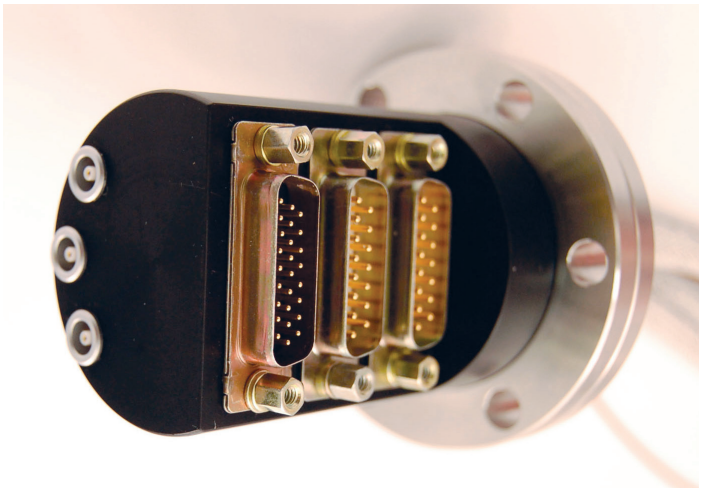
CUSTOMIZED SOLUTION CHALLENGES

Controlling vacuum and thermal subsystems, and measuring test results in real time, demands a complex architecture of the control system, with various networked PLCs, touch screens for localized control and PCs for the supervisory system and data gathering. Add to the mix new as well as legacy installations (see Retrofit Planning Challenges, below), and you're looking at customized rather than off-the-shelf feedthrough solutions. A vendor who can provide access to online AutoCAD drawings enables pre-configuration of custom applications that can be a real time saver. In addition, finding a feedthrough partner with both engineers and production onshore can enable design, prototyping and manufacturing of custom feedthroughs in as little as 4-6 weeks, rather than the 20 weeks or longer that an offshore source can take.

Customized hermetic feedthroughs come in all shapes and sizes, as seen in this family of PotCon feedthrough solutions.

RETROFIT PLANNING CHALLENGES

With many chambers in existing space simulation facilities decades old, we see a lot of maintenance challenges to ensure that program schedules are met. Many of these older facilities have existing feedthrough apertures that must be customized



This custom multiple D-sub feedthrough is an example of meeting today's feedthrough and connector require- ments through legacy access.

for today's digital test signals. In addition, many of these installations need feedthrough replacements due to common wear and tear or outdated configurations. Fittings that were considered "standard" two or three decades ago may no longer be available today. The duplication of historic designs may be needed, particularly if the original manufacturer is no longer available. New connections are also often needed for modernized technology or if the old feedthroughs no longer meet the needs of the project. Thus, there may be a need to retrofit a custom design into the existing assembly or into preexisting access holes in the system. Doing a little pre-engineering homework while you still have some time in the schedule can pay off big if problems are discovered. As these retrofits take place, you may want to consider tighter specifications for your thermocouple feedthroughs, designing in performance standards to meet future needs and reduce signal loss. These parameters may include the use of standard fittings, defining pin specifications and demanding use of thermocouple-grade copper pins. The end game is developing backwards compatible solutions that work with existing hardware, but can also satisfy today's demanding electronic needs.

PROVISIONING FOR BENCH TESTING

Bench testing of your equipment set ups before placing them in the chamber can dramatically reduce the time to troubleshoot. We're finding great

Plug to receptacle connectors allow easy bench testing using the same connectors.

interest in plug to receptacle, or PBTR, connectors, for space simulation applications. PBTR potcons allow the mating connectors to mate with each other in addition to mating to the potcon allowing environmental technicians the opportunity to mount the hermetic feedthru and ensure vacuum integrity while the electrical technicians verify electrical performance. These types of penetrations can also provide backup capacity in the case of failure or program changes. We recently worked with a customer to develop a "universal" port plate, as a fail-safe back-up.

The ability to easily mate and un-mate connections also reduces the potential for excessive wear on the wiring installed in the chamber. Furthermore, troubleshooting a vacuum leak in a system with multiple feedthroughs and/or thousands of wire connections can be frustrating, time-consuming and expensive. That's where certain solutions such as port plates can really cut the risk of leakage, and simplify troubleshooting.

SUMMARY

While I am certain there are challenges we have yet to meet, the concerns above reflect what we have encountered in the field across a wide range of vacuum chamber facilities. So rather than get backed into a corner with a late appearing problem or issue when testing is about to begin, spend some time at the front end of your project making the right material and fitting selections. As was stated earlier, like all engineering endeavors, the devil is in the details. Paying attention to your feedthrough requirements sooner rather than later is a lot less costly, and you will sleep easier as well. Please feel free to contact the author if you need any more details or additional information on solving your specific feedthrough challenges.

For additional information on DECo solutions, including product brochures and videos, please visit http://www.douglaselectrical.com.

For sales information, contact Chris Rempel at DECo by phone at (973) 627 8230, or by e-mail at crempel@douglaselectrical.com.