

Improving reliability with cryogenics

Cryogenics plays an increasingly important part in the development of electronics, but the components sold into this market need to be both incredibly reliable and well designed. By **Neil Tyler**

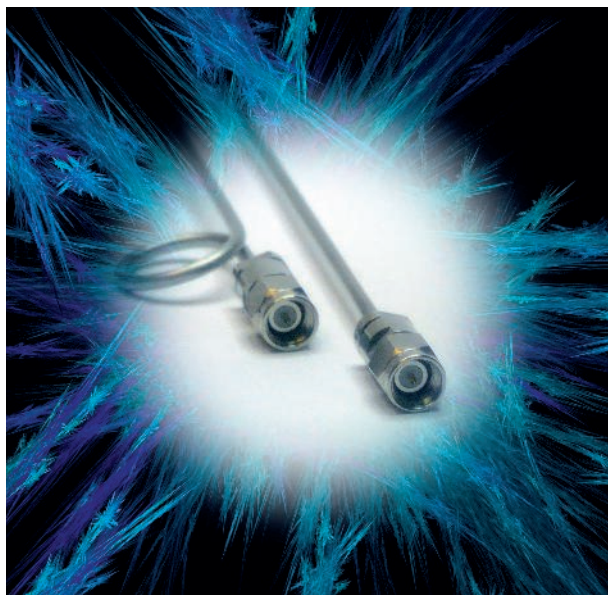
Cryogenics is the study of the production of extremely cold temperatures and is a field of science that looks at what happens when materials, whether metals or gases, are exposed to very low temperatures.

There are a wide number of potential and actual applications that use cryogenics. For example, as well as mission-critical cooling systems for space and science projects, such as the Large Hadron Collider or the Planck Space Observatory, cryogenics is being used for cold storage and transportation in the food industry; in the prevention of overheating in underground cables and wind turbine technology as well as in aerospace, telecommunications and electronics.

When it comes to electronics and the operation of electronic devices, circuits, and systems cryogenic techniques were actually being used as far back as the 1950s.

While often referred to as low-temperature electronics, or cold electronics, and despite being first used in the 1950s, it wasn't until the 1980s that a conference looking at the application of low-temperature electronics was actually held.

If you look at cryogenic semiconductor electronics, it can involve a circuit using a single transistor or a system that covers hundreds of large integrated circuits. It can include both analogue and digital systems and span the frequency spectrum from DC to 100s of GHz.



As transistor types have expanded to include Si, Ge, GaAs, SiGe and III-V semiconductor materials so the scope and use of cryogenics has actually increased.

So, why is cryogenic processing used when it comes to the development of electronics?

Well, it can improve the performance of the electronics in the form of lower noise, higher speed and increased efficiency. With cryogenic treatment of electronics, gaps within the structure of their metallic components can be reduced, so lowering the artifacts in the electrical current and producing a truer signal and providing better performance and endurance.

Among other attributes associated with cryogenics are that it has been

Above: The CryoCoax brand specialises in connectors and cable assemblies for cryogenic systems

found to extend the life of circuit boards in extreme conditions and that it reduces the residual stress found between the layers of thin film magnetic memory.

It has also been found to increase the contact life of relays, circuit breakers and switches.

Other benefits include: improved thermal and electrical conductivity, lower operating power, reduction of parasitic losses, diminished chemical and metallurgical degradation, and improved overall reliability.

So what kind of temperatures are we looking at? The range of temperature associated with cryogenics does tend to vary but is usually associated with temperatures that are below -190 degrees Fahrenheit or 123 degrees Celsius.

There are a number of ways to generate these kinds of temperatures, including the use of specialised deep freezers or by employing liquefied gases like nitrogen, and at those kinds of temperatures, the impact on materials can be profound.

British Cryogenics Council

The British Cryogenics Council (BCC) was established in 1967 to promote and extend interest in the science of cryogenics and now has over 100 members.

It looks to offer a broad spectrum of expertise from companies providing cryogenic products and services to universities undertaking low temperature research and end-users of cryogenics and cryogenic systems.

Interconnect supplier and manufacturer Intelliconnect recently became a member.

"Joining gives us the opportunity to extend the market reach of our cryogenic cables and components and to participate in the rapid development of what is a fast-growing field," explained the company's Managing Director, Roy Phillips.

"The cryogenics market has quickly become a significant part of our business, accounting for around 35

percent or our turnover,” according to Phillips. “A lot of our product is used in research applications, probably the biggest of which is quantum computing.”

Despite the use of cryogenics going back more than 60 years, it is a relatively ‘young’ industry and, according to Phillips, remains one in which the supply chain is still relatively under-developed.

Intelliconnect entered the market around 4 years ago when approached to source components and help manage a UK company’s supply chain.

“The opportunities within the space are enormous and not only do we manufacture connectors, adapters and cables but we are also sub-contracted to supply complete assembled units,” Phillips said. “We’ve invested heavily in new manufacturing and test equipment because the materials we have to handle are of a much higher standard – in fact we are looking at installing our own cryogenic chamber.

“As a result of this engagement and investment we are now a leading supplier of UK designed and manufactured cryogenic interconnect products and as a member of the BCC, are able to ensure that our products keep up to date with leading-edge research and market opportunities as they happen.”

Intelliconnect is also a member of the Cryogenic Society of America allowing it to extend the market reach of its cables and components beyond the UK and Europe.

The company’s growing range of cryogenic cables and components work to 2 K (-271.15°C) and can be used in a wide range of applications including: test and measurement, instrumentation, medical and material research and cryogenic systems including dilution refrigerators, superconducting magnet systems, low temperature detector systems, infrared array systems.

As Phillips explains, “Cryogenic systems need well-designed, reliable and repeatable cable assemblies and

we are able to provide customers with high volume standard products or unique custom designs. The key is to be able to work with them and supply the cryogenic components they need.”

He continues, “We combine decades of experience in the interconnect industry with a modern, streamlined approach and have long experience in providing defect-free, high-quality cryogenic products.”

In a market where the technical difficulties can be significant it’s crucial that the company has a close working relationship with its customers.

“Our designers and engineers spend a lot of time with customers and will work alongside them from start to finish of a project, to ensure the best possible solution is delivered.”

Companies and organisations working in this space also have to contend with a limited supply chain and because it’s not possible to use standard components, it can be difficult to source the right products when needed.

“We’ve had to be very innovative to meet the specific needs of customers. For example, we developed a solderless connector as in this space the type of materials that are used means that you can’t use soldering as a technique. The solution – a clamp-type connector – has proven its worth and is actually now being used in other sectors we supply as assembly

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times are quicker, it’s field replaceable and has a much improved electrical performance.”

As the market for these products has grown Intelliconnect has taken the decision to launch CryoCoax, a new brand that specialises in connectors and cable assemblies for cryogenic systems.

“The CryoCoax range of connectors has been developed to include sturdily constructed stainless steel interconnects including SMA, SMP, custom designed products and all common connector interfaces,” explained Phillips.

Cables and cable assemblies for the cryogenic market use advanced materials and manufacturing techniques with test capabilities to 40Ghz.

CryoCoax designs and manufactures standard, IP68 and glass sealed hermetic adapters and a range of attenuators, from 0dB – 30dB which are specially configured to withstand the low temperatures that are associated with cryogenics.

“Core capabilities include the ability to withstand temperature to 2K and below.

“We’ve also developed stainless steel cable assemblies to 40GHZ, niobium titanium cable assemblies to 40GHZ, cupro nickel cables, raw St/St and NbTi cable, non-magnetic cables, SMP connectors, crimp solderless and 2.9mm connectors and adapters, sealed adapters, hermetic connectors and adapters, attenuators and low temperature hardware,” Phillips explained.

The cryogenics space is an area of rapid growth and Intelliconnect is fast becoming a market leader in this space, suggested Phillips.

“We see strong growth for the industry because cryogenics is starting to be applied across so many different sectors.

“It’s a technology that is being used more, in more industries, and I think, as a business, we are in a good position to take advantage of this.”

Below: The company’s range of cryogenic cables and connectors is extensive

