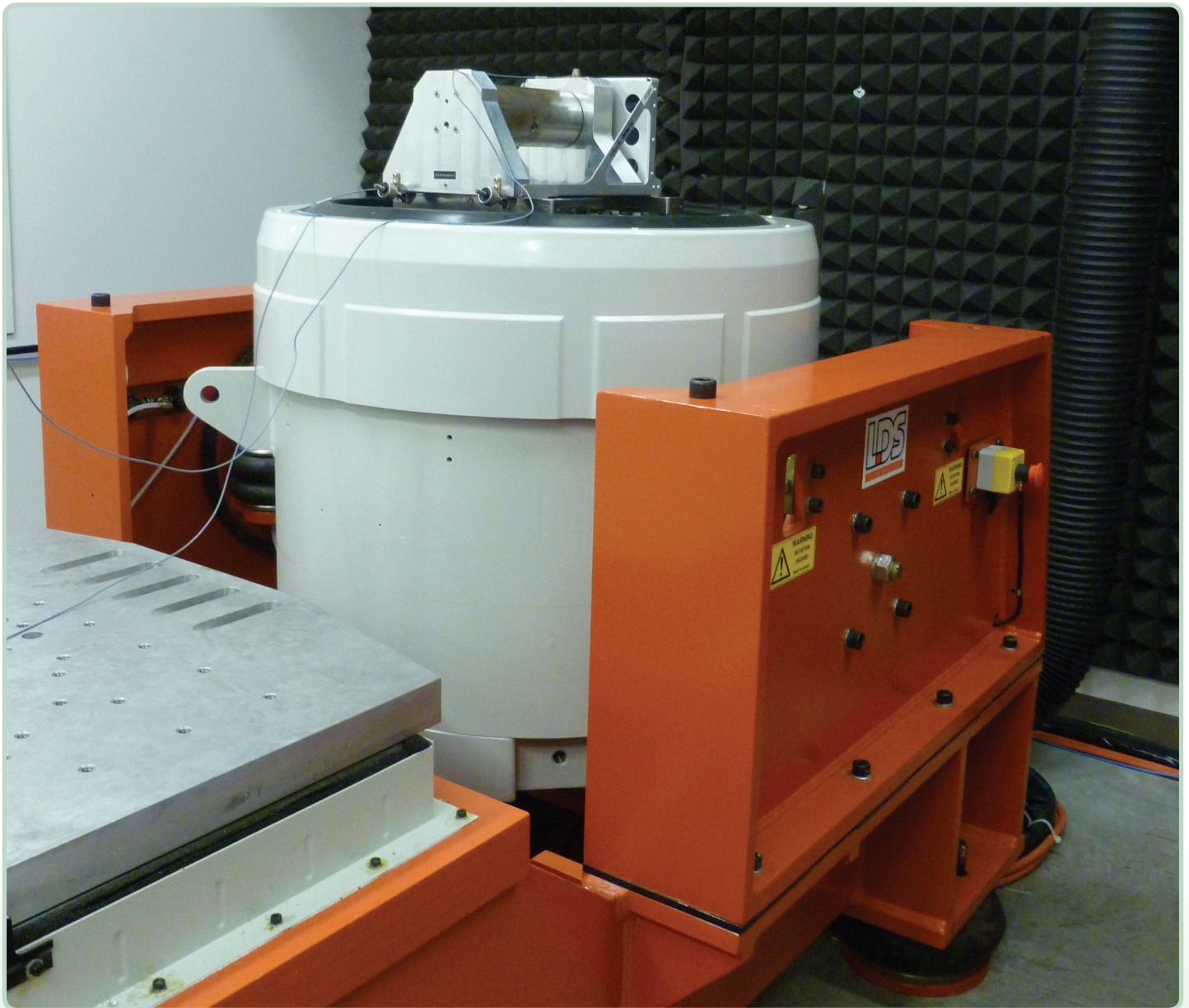


# CASE STUDY

## Carlisle Interconnect Technologies' vibration test system gives quick return on investment

USA  
Aerospace  
Vibration test system, accelerometers

*After investing in a vibration test system, the engineering team at Carlisle Interconnect Technologies has benefitted greatly from its new range of testing capabilities. As well as performing demanding tests for many engineers working in their group, they are now able to offer testing services for affiliated external companies.*



# CARLISLE

## INTERCONNECT TECHNOLOGIES

Carlisle Interconnect Technologies is part of the Carlisle Companies Inc., which is publically traded on the New York Stock Exchange (symbol: CSL)

Carlisle Interconnect Technologies itself has a number of core business areas, chief among which is the design and manufacture of all aspects of wiring, cables and connectors up to the level of complete, highly engineered equipment rack assemblies. Important business areas are:

**Aerospace** - Manufacturing of equipment racks, systems and components

**Test and measuring solutions** - Full engineering design services

**Medical electronics** - Pulse oximetry systems, ECG monitoring, medical imaging

With its headquarters in Saint Augustine, Florida, Carlisle Interconnect Technologies also has locations in the US, China and Switzerland, and a global sales force. Following a series of acquisitions it owns a number of famous brands. Major markets include the US, China, South America, UK and France.

### History

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The story begins in **1940**, when Henry Dudley Minich organised what was then known as Tensolite at 7 Hudson Street in North Tarrytown, New York. The initial emphasis was on products such as yarn, bristles, surgical sutures, decorative cords, ribbon and plastic textile sheeting.

In **1944**, the US Department of Defense awarded the company a contract for the manufacture of electrically heated gloves and flying suits for Air Force pilots. Then after World War II, work with insulated wire was continued, with two of the most successful products being hearing aid cordage and flexible phonograph tone arm wire.

In April **1950** the Tensolite Insulated Wire Company, Inc. was founded by Henry Dudley Minich and his son, Charles Harrison Minich, and the first line of products was wire with wrapped or extruded vinyl plastic insulation.

In **1960** Tensolite became part of the Carlisle group of companies, and in **1962** became the first company to develop a process to wrap polyimide tapes on wire, producing a tougher, lighter airframe wire.

In **1985**, they developed a unique process to extrude and expand PTFE in a continuous process. This led to a patented high-speed wire and cable insulation system.

In **1988**, they developed the first arc-track resistant airframe wire and called it Tufflite 2000, which is becoming the standard for airframe wire safety.

Starting in **1998**, they began to implement a strategy to vertically integrate into value-added cable assemblies, to provide superior high speed, high density and RF/Microwave cable assemblies.

In April **2008**, Tensolite acquired Carlyle Incorporated to create Carlisle Interconnect Technologies.



**“A major benefit of this investment is that it has reduced qualification and certification time on new products by several months”**

*Rob DeGrave, Mechanical Engineering Analyst*



## Customers

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Carlisle Interconnect Technologies' 8000 customers include Airbus, for whom they build equipment racks such as those that contain the passenger entertainment systems on the Airbus A380. Other well-known customers include Boeing, Lockheed Martin, Gulfstream, Learjet, Rockwell, Honeywell, and Northrop Grumman.

At least 90 percent of their business involves aftermarket retrofitting of existing aircraft, with the particular focus on upgrading entertainment systems, avionics, and satellite connectivity. At present, approximately 80 percent of its business is commercial, and 20 percent involves the military sector.

**“We found the Brüel & Kjør solution to be the most capable for the best price, being able to perform a very wide spectrum of test requirements”**

*Jeff Behlendorf, Manager of Airframe & OEM Equipment*

## Brands owned by Carlisle Interconnect Technologies

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**Carlyle Inc** - Manufacturer of aerospace-grade copper and fibre cable assemblies

**CDI Connecting Devices** - Supplier of high-performance coaxial connectors for RF/microwave industry

**ECS** - Designer and manufacturer of electrical and structural products and services, with core products consisting of highly-engineered wire and cable assemblies

**Jerrik** - Design and manufacturing centre for EMI filter and transient suppression connectors

**QMI** - Manufacturer of RF/microwave connectors and cable assemblies for demanding environments.

**Tensolite** - Produces insulated wiring and cabling with high performance and low weight

**Tri-Star Electronics International** - Provides high-reliability contacts for military-aerospace and others

**UniTrek** - Responsive supplier of RF assemblies and complex custom wire harnesses

**VEMCO** - Supplier of high-speed, high-density cable assemblies and complex medical cable assemblies

## Franklin facility

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*The average turnaround time at the Franklin facility from agreed drawings to delivery is about a month - something they are understandably proud of*

Franklin, Wisconsin, is where the aircraft rack and tray systems are made and tested for aircraft manufacturers. This is also where the vibration test facility is located, and where the engineering team performs sound and vibration testing for members of the Carlisle group, as well as outside companies – to whom they also offer their services.

Out of 235 people based here, the Franklin engineering team contains 65. With typically 30 projects in progress at any one time they are very busy, and are currently involved with the Airbus 350 and the Boeing 787 Dreamliner programmes – and they are growing quickly.



To make the aircraft rack and tray systems, sheet aluminium is punched, folded and then chemically finished. They make equipment racks in metal and composite materials which can weigh up to 90 kilograms when empty. Typical production runs are 50-100 components, but can be 1000s for some products. Speed and quality are equally important here, and according to Jeff Behlendorf, the Manager of Airframe & OEM Equipment Engineering, “Our average turnaround time from agreed drawings to delivery of core products is about a month, and we are very proud of this.”

## Vibration test system

The system mainly tests designs during R&D, especially for complete life-cycle simulation, generally based on industry-standard test profiles. As with anything related to aerospace, exacting detail and specified tests according to customer and industry standards are performed, including shock testing to simulate events such as an aircraft's undercarriage experiencing a tyre blowout on the runway.

The Franklin engineering team uses the vibration test system to test connectors, wiring harnesses, metal modules and fittings. Thanks to the time savings that the system has enabled, and the testing services work for third-party aerospace customers, Jeff Behlendorf is pleased with their recent acquisition. "It was commissioned just six months ago, and has already paid for itself," he said.

During testing of the aluminium trays shown in the picture, the size and mass of the load that they will endure in actual use are simulated. With the choice of using the slip table or the head of the V875 shaker itself, they can accommodate many different products and a variety of test types.



**"It was commissioned just six months ago, and has already paid for itself"**

Jeff Behlendorf

*Carlisle's vibration test system consists of a V875 air-cooled electro-mechanical shaker fitted with a head expander and a slip table to accommodate larger test objects. A controller loaded with software tailored to the specific tests feeds the signal into the power amplifier (at right), which then delivers it to the shaker. Type 4513 accelerometers monitor the test object's actual movement.*





## Test types

**Sinusoidal** tests are used for propeller aircraft applications, to simulate windmilling (an imbalanced engine while in flight), and tyre bursts.

- Up to 3628 kg (8000 lb)
- 91g acceleration
- 75 mm peak-to-peak

**Random** vibration is used for jet aircraft applications

- Max 3311 kg (7300 lb)
- 76 g acceleration
- Up to 2 kHz

**Sine-on-random** is used for propeller aircraft applications

**Random-on-random** is used for helicopters and military vehicle applications

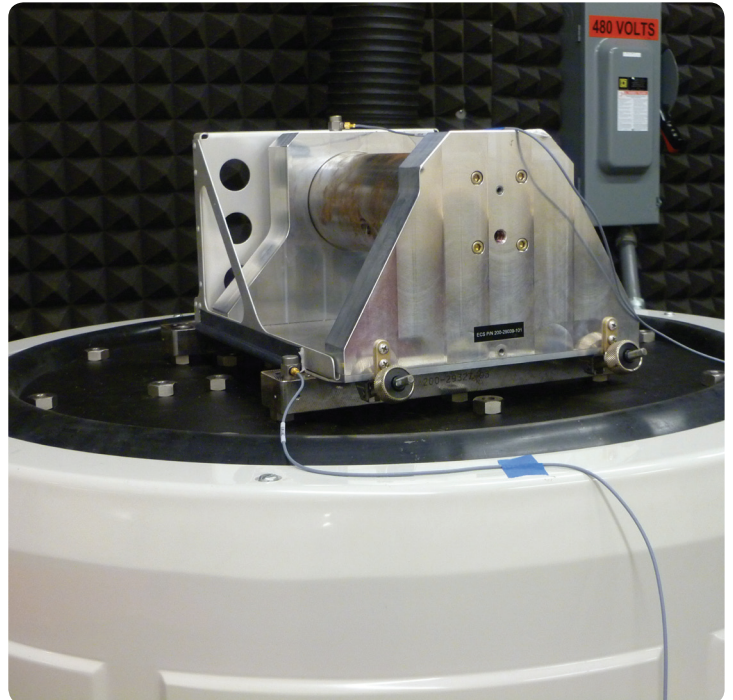
### Classical shock

- Up to 9933 kg (21900 lb)
- Terminal sawtooth
- Pulse
- Half-sine pulse

### Shock Response Spectrum

A short test is 36 seconds long, and up to 27 Hz. This includes simulated landing gear tyre blowout, which would clearly give a considerable shock. The longest test-to-simulation lifecycle is typically 12 hours, and the lowest frequency test is 2-30 Hz.

For the Franklin engineering team, it is very beneficial to show their customers the lengths that they go to in order to guarantee the quality of their products. As Rob DeGrave, the Mechanical Engineering Analyst says, "Customers often want to be present and witness tests, and are very complimentary about the system and its test environment." They have developed a special test room that is very quiet, which helps to create a good customer experience.



## Exactng standards

Everything is tested to the specified industry standards that are prescribed for helicopters, jets, turbojets and space vehicles, as well as the very specific customer requirements for each type of aircraft. Aerospace manufacturers and operators require very formal and specific test reports, in addition to which, data from the tests is stored for as long as the aircraft is operational. Test reports can be up to 100 pages of highly detailed information and can include photos and videos. They include 3D CAD, Finite Element Analysis, and modal search criteria.

Just as with their aerospace industry customers, their work with the medical industry is similarly exacting. "The medical industry is closely linked to aerospace, and we do testing for our medical division at Franklin. It is low volume, but the standards when working with a company like GE medical are as expected – extremely high," says Jeff Behlendorf.

### Service agreement

*Accelerometers and vibration controllers have to be calibrated once per year, which is simplified though a service agreement, entitling Carlisle Interconnect Technologies to elevated levels of support.*

## Buying Brüel & Kjær

The vibration test system was installed in February 2010, and was commissioned without a hitch and ahead of schedule – delighting Jeff Behlendorf who worked on the acquisition process. He was instrumental in the decision to choose this system over the competitors, saying “We found the Brüel & Kjær solution to be the most capable for the best price, being able to perform a very wide spectrum of test requirements.” Having solicited recommendations, they came to this conclusion to because, as Jeff Behlendorf says, “Brüel & Kjær offered a better value than the competition.”

## Future

The Franklin engineering team are looking forward to a long life and great payback from their vibration test system, which is helping them as they grow quickly. “A major benefit of this investment is that it has reduced qualification and certification time on new products by several months,” says Rob DeGrave.

Among the areas that they would like to see some expansion is working with military projects, while in terms of technology, they are considering buying a modal analysis test system, and are also considering making the move to calibrating their accelerometers in-house.



*At left, Jeff Behlendorf is Manager of Airframe and OEM Equipment Engineering, and has been working in aerospace at this facility for 13 years. He has a degree in physics from the University of Wisconsin.*

*Rob DeGrave is a Mechanical Engineering Analyst, and has been working at Carlisle for six years. He has a degree in Civil Engineering and Mechanics, and after starting as an analyst is now also working on project engineering and product development, whilst still maintaining his analyst responsibilities. Rob is also part of a team that is responsible for the vibration test system and work scheduling.*