

What is Hi-Rel or High-Reliability for connectors?

High-reliability is the use of features, systems or procedures to avoid failure in demanding circumstances or applications. In markets such as Space, Aviation or Defense, high-reliability is dictated when the task or equipment is mission-critical and involving risk to human life. Connectors certified for these markets are qualified or released to specific standards relevant to each application. They are amazingly robust, able to withstand the utmost in environmental extremes, and fully tested and inspected – the safe but expensive choice.

Definition of Hi-Rel connectors

In the connector industry, the term “high-reliability” is defined more by the types of environmental conditions encountered, and may include unmanned and less life-critical functions. These factors include:

- Vibration and shock
- Operating Temperatures – high, low or variable
- Protection against physical knocks
- Wear resistance
- Strain relief on cables

Can I just specify certified connectors to a standard?

You could specify certified connectors everywhere on your build – but this comes with a technology and cost penalty. Typically, qualification to a standard (and listing as an approved supplier by the regulating body) is a lengthy process and may have taken several years to achieve. Specifying from an approved list may mean older, heavier, larger and more expensive components are your only choices. It becomes very difficult for the long process to keep up with the pace of development. You may even find that a lot of qualified components are not even RoHS compliant, which could be an issue depending on your market sector.

It’s also an expensive qualification process, and this will be reflected in the final price of the products. Add in additional costs relating to increased testing, yearly qualifications and even expensive memberships. You won’t see it itemized separately, but the cost is there.

What markets or applications should consider Hi-Rel connectors?

Many applications could benefit from specifying a more rugged and durable connection, such as:

- Aviation – flight systems, engine control, in-flight cabin amenities and ground control stations
- Unmanned vehicles – UAVs (Unmanned Aerial Vehicles), UUVs (unmanned Underwater Vehicles), UGV (Unmanned Ground Vehicles), Remote-controlled robotics
- Space – CubeSats and Satellites, rocketry control and guidance, launch control systems
- Motorsport – telemetry, ERS and control systems, onboard cameras and sensors



- Defense – COTS (Commercial Off-The-Shelf) substitutions, targeting and guidance, radar and detection systems, field communications
- High-End Industrial – portable devices, remote and outside operation units, factory automation with high vibration, robotics, down-well controls



What features do the High-Reliability Connectors have?

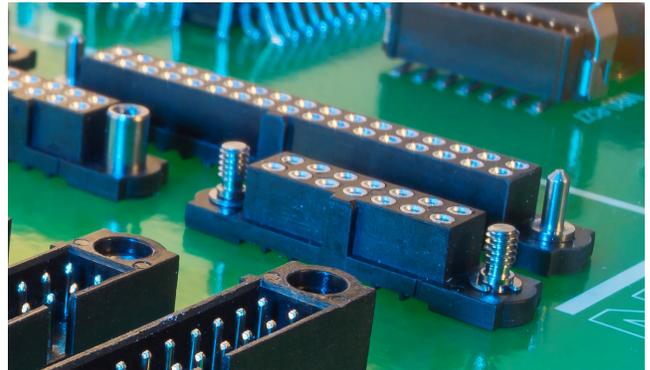
Let's look at each of the critical factors and see what features a connector might include to cope with the challenge.

Vibration and Shock

Vibration is an ongoing shaking, either constant and steady, or varying in amplitude and frequency (such as a combustion engine). Shock is a single sudden impact (like dropping your phone). In either instance, the electrical signal or power through the connection should continue without interruption.

There are usually two separate design features in the connector that assist with this aim. Firstly, the design of the actual contact area, where the two connector halves make electrical connection. More contact faces rather than less are often a good choice here – for instance, 4 contact beams instead of 2. This helps make sure that there will always be at least one beam maintaining contact, no matter in which axis the shaking occurs.

Secondly, a fixing method between the two connector halves, such as jackscrews or latching. This prevents the halves from shaking or bouncing apart. With the combination of these two features, you should see a high rating for both shock and vibration tests.





Operating Temperatures

Typical commercial connectors may have operating ranges from -25°C to +85°C up to -40°C to +105°C. A high-reliability range will push the lower limit to -55°C or -65°C, and the upper limit to at least +125°C and even to +175°C. These higher figures are the type of temperatures required for control systems nearer engines. The lower figures are perfect for high-altitude flight – at 35,000 feet the air temperature is about -54°C.

This additional temperature range is achieved by material choice, such as higher-grade phosphor bronze or beryllium copper contacts. Plastic housing material also needs to be able to keep its shape and not crack or deform.

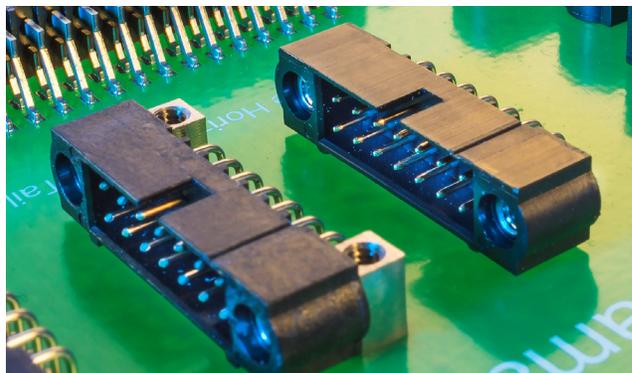
Physical Knocks

Separate to electrical connection through a shock, this is more about the connector construction itself being robust enough to handle bumps and thumps. Whether from tools slipping elsewhere in the build, or during maintenance, there should be enough material with good strength between the outside world and the contacts, preferably both unmated and mated. Shrouding and polarization will also prevent damage to the contacts during mating, making sure that connectors cannot be forced together wrongly. Bent pins and rework can slow down your assembly process.

Wear Resistance

Most plastic housings will be good at resisting wear over the long term. But if you are doing multiple testing regimes, how is the wear resistance on the contacts? Durability is the key specification here. This is the minimum number of mating cycles for the connection pair. Commercial connectors can be as low as 30, although some may achieve 300. High-reliability connections will achieve 500 or 1,000.

Note, we're talking about classic board-to-board and board-to-cable internal connections here – I/O connections such as USB-C are rated up to 10,000 cycles, but their design is specifically aimed at high levels of mating cycles and not some of the other factors discussed.



Strain Relief

Cable connections are often subject to more stress and strain than board connections. From users pulling on the cables, to tight bends around other areas of the equipment, to the cable weight pulling on the connector under vibration. One of the features that helps with strain relief has already been mentioned as a feature to help with vibration – namely jackscrews or latches. These will prevent connections from being pulled apart, either slowly over time or under sudden load.

The other feature is the addition of backpotting to your cable assembly. This will help the individual cable contacts stay correctly positioned within the connector housing. Some connectors will have specific extensions to the rear of the housing to hold the

backpotting in place while setting, but temporary walls can also be used. Cable connector hoods may also be useful, either fitted with cable clamps or as a container to hold the backpotting.





How can Harwin help?

Harwin have spent the last 40 years specializing in high-reliability connectors. Starting with the original Datamate, we now have an extensive range of connectors to suit many different size and current requirements:

- Datamate L-Tek – the original latched 2mm pitch connector system
- Datamate J-Tek – 2mm pitch with jackscrews and higher pin counts
- Datamate Power – 4mm pitch with jackscrews and up to 40A per contact
- Datamate Coax – 4mm pitch multiport ganged 500hm, 6GHZ contacts
- Datamate Mix-Tek – combining 2mm and 4mm pitch for signal, power and coax in one connector
- M300 – 3mm pitch with jackscrews for 10A per contact
- Gecko with Latches – 1.25mm pitch micro-connectors with space and weight savings
- Gecko-SL – 1.25mm pitch with screw-loks for fast mating
- Gecko-MT – adding 10A contacts to 1.25mm pitch signal for the smallest, lightest mixed-layout connectors

These connector ranges combine all the features listed above to create a wide choice of connectors at home in many different environmental challenges. The Datamate series is a firm favorite in many applications and carries a proven history of performance and quality. The newer Gecko and M300 ranges have already established a firm following in multiple markets.

We're not standing still – new variations for the existing ranges are often being added, and new high-reliability connection systems are also in development. Keep watching Harwin.com for the latest news.

Explore the High-Reliability connector ranges to find your best choice of rugged compact connectors.

