

Connector Protection

EmbedTek works with many systems suffering from inconsistent electrical connections – a persistent industry challenge. A bad connection resulting from contamination, oxidation or mechanical damage of plated contacts can lead to failure of the more critical OEM device, frustrating end users and damaging the reputation of the OEM. Proactive research and development led EmbedTek to employ a process that significantly mitigates or eliminates the problem. The process has been so successful that we have applied for a patent and are actively sharing our story with the larger embedded community.

Problem Scope

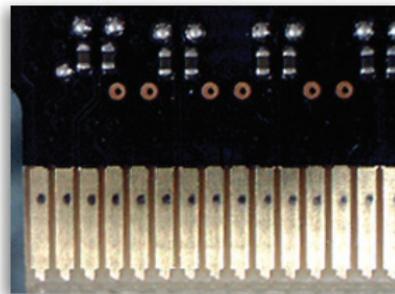
In an embedded computer, a high speed bus or other interconnects link PCI boards, memory modules and other components. We investigated the factors that affect reliability of these connections, and looked for ways to eliminate problem areas.

The real issues start for our customers when the failure of a relatively simple computer cascades to the expensive and critical OEM device. These failure modes are frustrating for the end users, and can tarnish the reputation of the OEM of the larger system. Patients in a hospital may have to reschedule critical tests, soldiers may not receive training, and manufacturing lines can be brought to a stop.

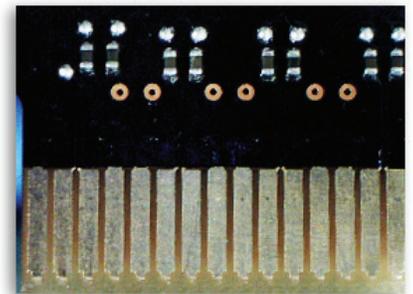
Further compounding the potential problem, many OEM customers use racks/clusters of systems to serve a single device or many devices. A cluster with 10-40 systems in one application is much more likely to have this type of failure mode and is likely to have repeated failures.

Photographs of contacts following prolonged shock and vibration testing

Video Card

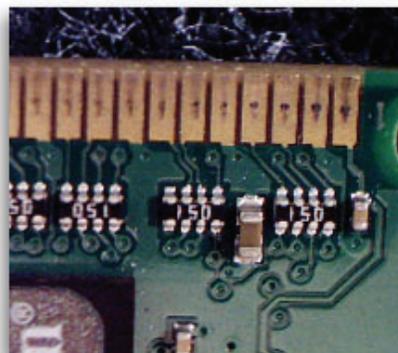


Untreated

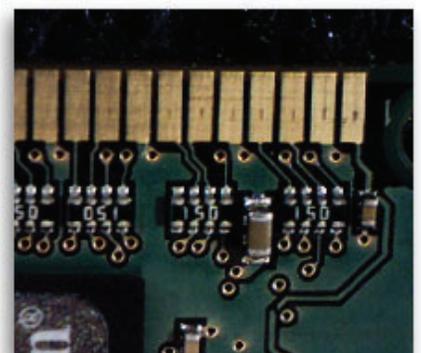


Treated

Memory Module



Untreated



Treated

Analysis and field corrective action

Inconsistent connections can be caused by contamination, oxidation or mechanical damage of the plated surface of the contacts.

- The board or memory module can be contaminated by the original manufacturer, arriving at the integrator already contaminated. Contamination can also occur when it is improperly handled during assembly.
- Normal heat or humidity can cause corrosion or oxidation of the contacts. Gold or silver plating can minimize, but not completely prevent, corrosion.
- Mechanical wear can physically damage the edge connector or the receiving slot of the system board. Initial insertion of the board when the system is assembled results in very minimal wear. When the system is exposed to shock and vibration, small relative motion between the parts creates additional wear and can become serious over time.

Common failure modes in the field may be reported as a “failure to boot,” or the customer will note that the system booted, but then displayed a warning that certain memory or devices were unavailable.

Repair procedures and field corrective action can be problematic. Since the bad connection does not occur every time, a repair facility that receives a returned system may report “no problem found.” The system in question may then be returned to the field, where it will exhibit the failure mode again.

The situation can often be resolved by “reseating” the indicated component, or removing and reinstalling all of the boards and memory modules. The

Diagnosed Causes for Inconsistent Connections:



Contamination of the contacts, by the component manufacturer and/or the system integrator



Oxidation/corrosion of contacts caused by humidity, salt air or other environmental conditions during storage and/or use



Shock and vibration during transport to the site or during operation

mechanics of removing and reinstalling may provide improved connectivity at least temporarily and the system may start up correctly. The failure mode will likely reoccur, or a new failure mode may result from unqualified handling of the device.

A comprehensive approach to the problem

We are seeking patent protection for our process which employs a multi-level approach of physical card retention, careful cleaning and the enforcement of safe handling practices, plus the application of a synthetic material to protect the plated contacts. This coating, developed by experts in the contact lubricant industry, covers the surface and protects the metal against both mechanical wear and corrosion.

The method of application is critical, and ensures that the material is equally distributed across the contacts and prevents the lubricant from migrating to other parts of the system.

Validation of the material and process

EmbedTek performed a series of tests to validate the effectiveness of the process, and to ensure that the material would not impair mechanical characteristics of other materials used in card construction.

The first set of tests established that the coating acted as a lubricant, and protected the metal against mechanical wear during shock and vibration. Two identical systems were built: the first one employed industry best practices for card retention and cleaning; the second system was built following all those practices plus the synthetic material, applied per our technique. The systems included a large video card, representing a typical PCIe application, as well as a memory module.

The test procedure we followed was derived from ASTM standards, and reproduced an environment containing high levels of vibration. After the first hour of testing, the non-lubricated unit experienced memory failures that required reseating of the memory

module to restore functionality. The failures continued to occur over the next 5 hours of testing. After the 8th hour, the non-lubricated unit experienced a video card failure and was no longer able to function. The failed unit was then removed from the test.

The testing continued on the treated unit and was run for an additional 104 hours at the same vibration profile. Upon completing the 112 hour test, the lubricated unit was removed from the test. The lubricated unit did not experience any connection-based issues during the testing.

The systems were then disassembled and the connections were cleaned and inspected. The example photograph of the video card contacts shows that the non-lubricated connectors have visible pitting at the highest compression point of the contact as well as longer, shallower wear lines over the length of the contact. In both tests, the lubricated connectors show minimal wear.

The second series of tests confirmed that the material would be compatible with materials used in the connectors and nearby components. Multiple components were selected, representing a wide range of materials commonly used in board and memory module construction. In the test, the coating was applied to a small area of the part, while leaving other areas unprotected. Then the entire part was placed in a thermal chamber at 70°C (158°F) for 336 hours. The parts were taken out of the chamber and allowed to stabilize at room temperature. Once cool, multiple durometer measurements

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were performed on each part to see if the material was damaged or softened. The test established that there was less than 10% change between the coated and uncoated areas for any of the tested materials.

The testing validated claims of reliability for connectors protected with the synthetic material. Additionally, the lubricant had no negative impact on any of the materials used in card construction.

Result

EmbedTek is applying this overall process on systems and racks of systems today with great results. We incorporate this process as part of our solutions to our customers, without applying additional costs. This is a win – win proposition as the costs associated with this field failure mode impact EmbedTek and our customers, whether through direct service costs or the impact of lost revenue due to a poor end customer experience.

Patented process for contact protection:



Physical card retention to minimize movement during transit or operation



Thorough cleaning to remove oxidation or contaminants at the time of assembly



Enforcement of safe handling practices during assembly



Careful application of a synthetic material to provide mechanical and oxidation protection after delivery

EmbedTek designs, invents, and manufactures computers, software, sensors, cameras, and displays for original equipment manufacturers. Our systems improve the quality of imaging in healthcare, simulation programs in the military, video analytics in security, and much more. Throw any challenge at us, from demanding environment and ergonomic requirements to High Level Assembly and nonstandard I/O. We'll evaluate it, carefully attack it, and solve it.