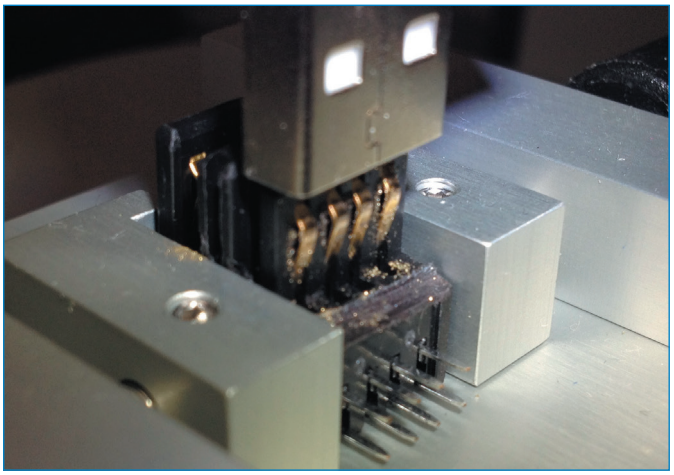
USB Connection Testing

Application Note

In recent years USB connectors have become a standard means of sharing both data and providing power to a variety of devices. Therefore these connectors are required to be robust and last reliably for long periods. Some connectors may suffer from wear due to repeated insertion and extraction, so it is important to know how many cycles of insertion and withdrawal a USB connector design can sustain without a degradation in its electrical or mechanical performance.

Cyclic loading not only provides useful information on connector lifetime, but is also a means of testing design changes, such as pin shape, spring force, coatings and lubrication.

Complete connectors or individual pins can be tested, and electrical resistance measurements can be used to assess the damage done by small repeated movements (fretting) see figure 1.



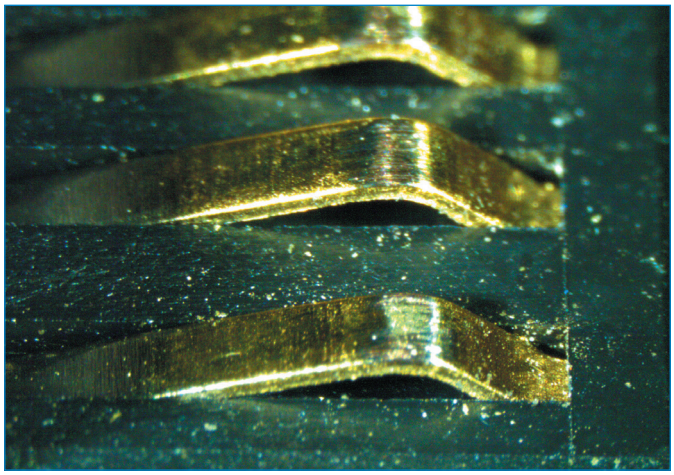


Figure 1: Test for fretting or test individual pins.

Nordson DAGE

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Understanding Connectors

There are several methods to test connectors:

- Insertion Force – the maximum push force required to push the two halves of the connector together
- Withdrawal Force – the maximum pull force required to pull the connector apart
- Contact Resistance – the electrical resistance associated with the point of contact, typically around 10-30mΩ
- Fretting – small rubbing movement between surfaces that are forced together.
- Fretting Corrosion – oxidation of contacts due to fretting
- Spring Constant – stiffness of the contact. Stiff contacts create high friction forces which can reduce fretting and contact resistance but result in higher insertion and withdrawal forces

The optimum test method depends on the materials being used and their attributes.

Test Method

Nordson DAGE have worked with the Manufacturing Technology Centre (MTC) to develop bespoke tooling and test methodology to characterize connector integrity and degradation through cyclic insertion and withdrawal testing.

The Nordson DAGE USB connector wear jig has a self-aligning function that minimizes the loads in the X and Y direction while the USB connector is being moved in the Z direction. This jig can also be locked after the initial alignment to simulate withdrawal processes where the connector is held rigidly.

Contact Material	Attributes
Tin	Low cost, few mating cycles, susceptible to fretting corrosion
Hard gold	High resistance to corrosion, low insertion force, high number of mating cycles
Silver	Mainly used for high current contacts
Hard gold flashed palladium-nickel	Particularly suitable for low signal levels, low wear, high number of mating cycles

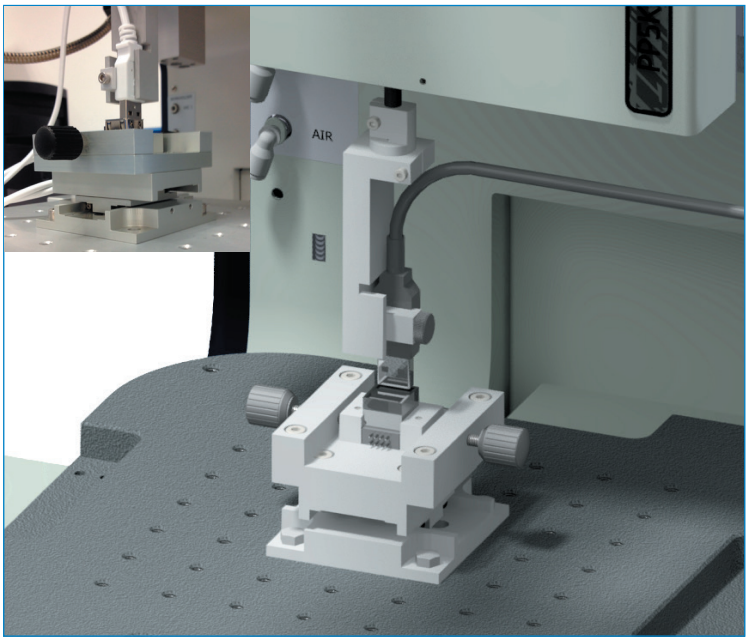

Figure 2: USB self-aligning connector jig.

Two Ways of Testing

The Nordson DAGE 4000*Plus* provides a flexible testing platform, with Paragon™ Materials Software, but sometimes a specialist or custom jig is needed to support samples such as USB connectors. To measure the cyclic performance of a USB design, the connector must be repeatedly inserted and withdrawn from the mating connector, while measuring the force of insertion and withdrawal to understand its mechanical performance, as well as measuring its electrical performance, such as pin resistance, within the same experiment.

The instrument can interface with any 0-10 V external measuring device, so a resistance meter can be used to produce a resistance versus time graph in real-time, during the experiment. Paragon Materials Software can trigger the data capture in external devices as well, for multi-channel data capture devices.

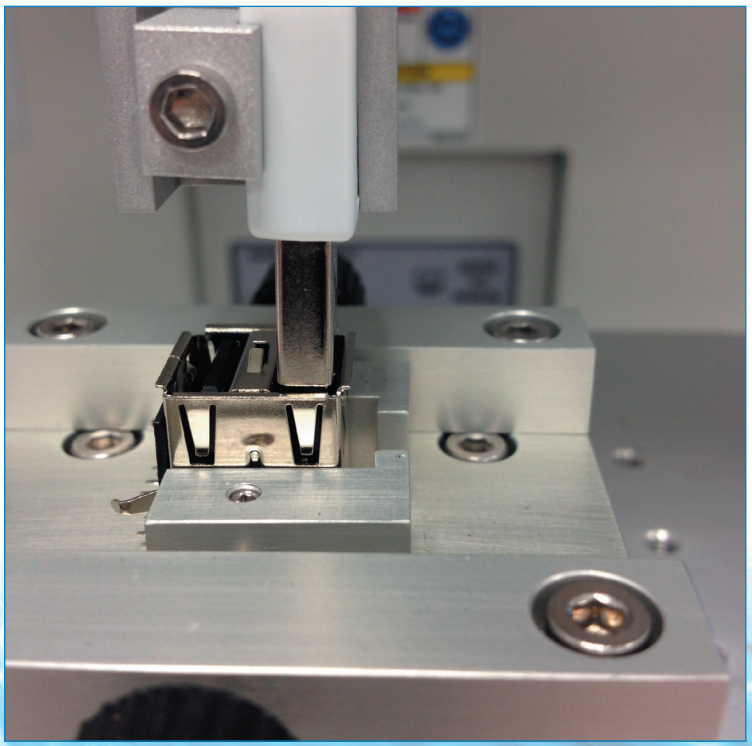

Figure 3: X, Y and Z axis control to < 1 micron for connector alignment.

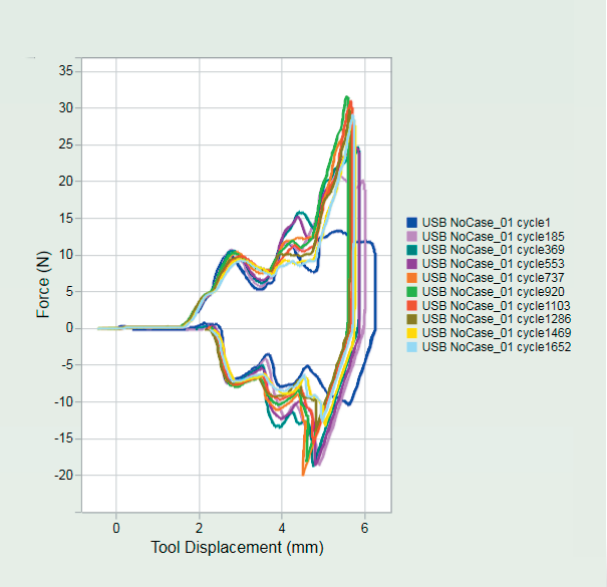

Figure 4: Paragon Materials software interface showing multiple test cycles.

Testing is performed to the following standards:

Standard	Test
IPC-TM-650	3.4 Durability, connectors
IPC-TM-650	3.18 Mating and unmating force, connectors
EIA-364-09C	Durability test procedure for electrical connectors and contacts
MIL-STD-1344A	2012.1 Contact insertion and removal forces 2013.1 Mating and unmating forces 2014 Contact engagement and separation

Nordson DAGE, The Partner of Choice for Advanced Testing

Instead of designing and constructing a bespoke testing frame to carry out this experiment, the Nordson DAGE micro mechanical tester can be used. It is a simple to use, highly flexible platform for a wide range of mechanical testing. With different cartridge and software options available, the experiment can be very quickly and easily altered.

The Manufacturing Technology Centre (MTC)

The MTC develops and proves innovative manufacturing processes and technologies in an agile, low risk environment, in partnership with industry, academia and other institutions. The MTC focuses on delivering bespoke manufacturing system solutions for our customers.

The MTC operate some of the most advanced manufacturing equipment in the world, and employ a team of highly skilled engineers, many of whom are leading experts in their field. This creates a high-quality environment for the development and demonstration of new processes and technologies on an industrial scale.

The MTC is part of the High Value Manufacturing Catapult, supported by Innovate UK.

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