

- SCOPE: What is Fatigue Testing?

A paper clip bent back and forth appears to weaken with each cycle. We call this process fatigue, from the French fatigué, meaning to tire. This is a low cycle fatigue test. As the wire is thin it is easy to apply relatively large strains and the clip breaks in just a few tens of cycles. If you repeat the experiment, bending the clip by smaller amounts, the number of cycles to failure increases.

Fatigue is form of sub-critical crack growth and provides a mechanism for growing a crack until it is long enough for the applied load to cause catastrophic failure. A small latent crack in a circuit board can propagate as the board expands and shrinks with change in temperature until it eventually breaks a track and the board ceases to function. Fatigue failure in un-cracked materials is generally attributed to the initiation and subsequent growth of a crack under cyclic load or strain. Smooth samples can form surface cracks due to the irreversible nature of plasticity. For some materials, such as mild steel, there appears to be a lower limit of stress (endurance or fatigue limit), below which a crack will not form no matter how many times it is cycled. For other materials, like aluminium, this does not appear to be the case. Standards tend to specify a fatigue strength, which is the stress below which the sample will last more than a large number of cycles, generally taken to be 10^7 or 10^8 cycles.

More often than not cracks start at material defects which act as powerful stress concentrators and with each cycle the crack gets longer until the material eventually fails.

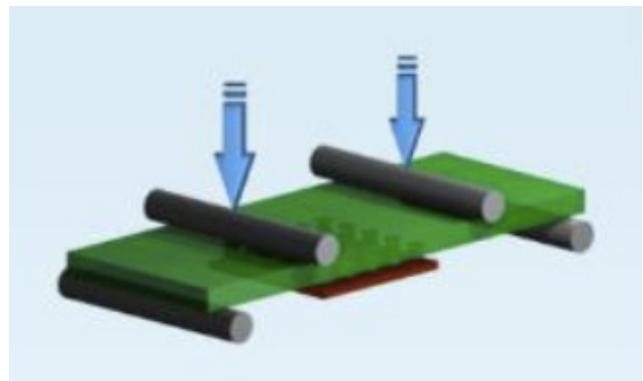
TYPES OF TESTING:

PUSH is designed for bend or compression testing. In this mode a cyclic pushing load is applied to the sample.. One of the main applications is to apply cyclic strain to board interconnect through bending. Either 3 or 4-point bending can be used, but it is more usual to use 4-point bending where the high level of surface strain is spread over the entire span of the central rollers. The image to the right shows a 4-point bend test setup.

In Test Parameters the user enters the maximum & minimum compressive loads, the hold time for each and the increasing and decreasing ramp rates.

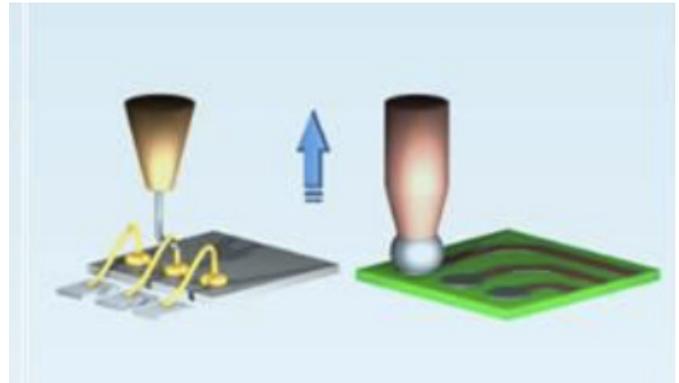
The cycle repeats until one or more of the End Point Detection parameters are met or the user ends the test.

The external input can be used to record board strain or to stop the test when the resistance of a chain of interconnects exceeds a set value. Where multiple gauges need to be recorded, the external input can be used to synchronise the force-displacement data, with a data logger. Resistivity measurement is discussed in IPC/JEDEC 9702 and positioning of strain gauges in IPC/JEDEC 9702 & 9704.



PULL is used for tensile tests, where the load is to be cycled between minimum and maximum tensile loads.

Probably the biggest application for PULL mode is pad cratering. Cyclic loading can be used to propagate small latent cracks until the pad fails during the test or after applying a small static load.



PUSH-PULL is used to test solder joints, where the joint or component is loaded first one way and then the other. The tool applies the set load first in one direction and then in the opposing direction, repeating this cycle. The displacement is adjusted automatically to get the desired load.

COMPONENT is for cyclic testing of connectors, buttons and keypads. Testing is done under a cyclic displacement with hold periods at the extremes of displacement. Connector failures are generally associated with abrasion of the contact materials and the external input can be used to monitor this.

Stage 1 – The user enters the uppermost position and the length of time in seconds that the tool should remain in this position during the cycle.

Stage 2 – The user enters the rate (insertion rate) at which the tool will move down to the lower position.



Stage 3 – The user enters the lowermost position and the length of time in seconds that the tool should remain in this position during the cycle.

Stage 4 – The user enters the rate (retraction rate) at which the tool moves from the lower to the upper position.

The cycle repeats until one or more of the End Point Detection parameters are met or the user stops the test.

Connector testing is generally about contact wear. Repeated insertion and retraction of connectors wears away coatings and can lead to corrosion of the base metal. The products produced by wear, in general, have a detrimental affect on the insertion force and electrical resistance of the connections. The characteristics of connectors are controlled through the design of the mating parts, the materials used and in some cases, the use of lubricants. Some information on measuring the resistance of contacts is given in ASTM B539 & B794.

Cyclic loading of connectors not only provides useful information for determining the number of times connectors can be plugged and unplugged, but is also a means of testing design changes, such pin shape, spring force and coatings.

Reference Material: Nordson Dage