

# Which board analysis is right for your board?

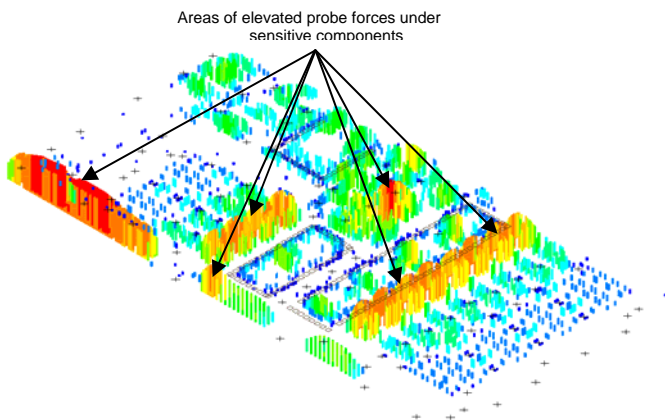
As circuit boards become more densely populated with components the need for test locations also increases. It is difficult for PCB designers to get one test point per net, much less having locations for board pushdowns or supports. Signals are rarely fanned out away from the BGAs, so engineers are left asking "Is my circuit board exposed to high levels of strain during test"? Are solder joints and components getting fractured?

## What processes are available from Circuit Check to prevent damage to PCBs during test?

- Probe Force
- Finite Element
- Strain Gage Testing

**Probe Force Analysis** is a visual design tool not requiring the extensive modeling and computing time associated with a Finite Element Analysis. Components and other board features are not modeled, resulting in probe forces being overstated. High probe force areas are quickly identified, allowing our engineers to proactively place pushdown features and change probe spring forces to reduce possible board flex.

### Example of Probe Force Analysis



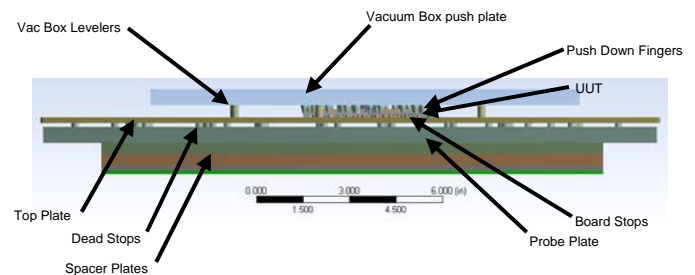
The Probe Force Analysis on this 0.032" thick panelized board with cut outs indicate as the fixture is currently designed the probe forces will be slightly elevated under BGAs. This board has had a history of high field returns

and Circuit Check's experienced mechanical engineers will recommend Finite Element Analysis be performed.

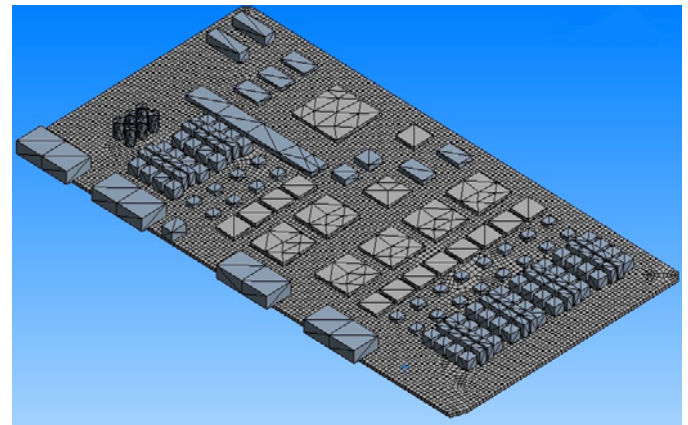
**3D Finite Element Analysis** is a method to mathematically analyze a model of the test fixture and PCB by dividing it into thousands of smaller pieces called elements. This powerful software tool can easily pin point excessive strain on the PCB caused by probe force and hold down features.

FEA provides **proactive results** since it is used as a design tool so it must be completed before initiating any fixture fabrication.

### 3D FEA Fixture Model



### 3D FEA PCB Model

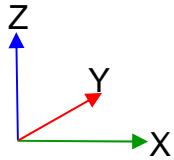


**Why all of the modeling?** The analysis takes into account the flexing of the fixture itself. This enables the fixture design to be easily modified reducing strain on the PCB.

The PCB and fixture are modeled in 3D, since stresses and strains are not uniform on all surfaces as they are in a 2D model. The increased accuracy that 3D provides allows precise changes to the fixture leading to reduce strains applied to the PCB.

The 3D model simulations take into account the different contact types. **Frictionless** – allows modeled parts to react as if they are independent parts, simulating motion between the PCB surface and the fixture's pushdown features (push fingers, BGA stilts, push blocks).

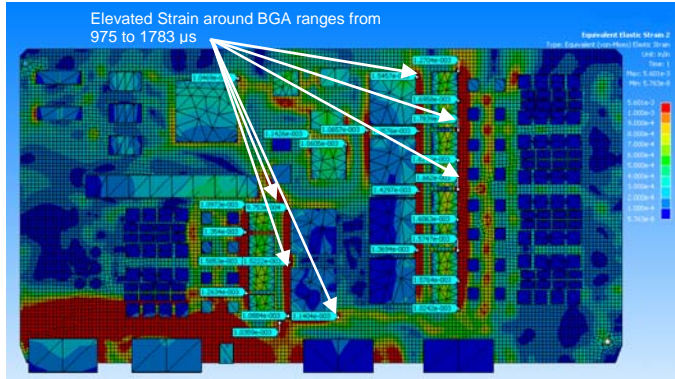
The **Bonded** modeled parts act as if they are joined as a singular unit like most of the primary fixture plates and all contact pairs that are not modeled as frictionless.



**Degree of Freedom (DoF)** each node of the model has 3 degrees of freedom.

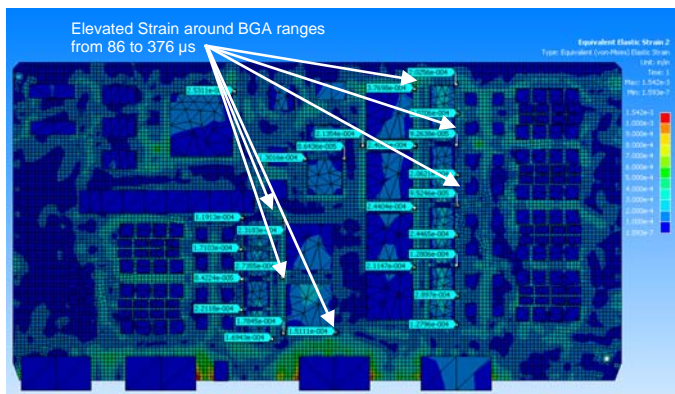
This is especially important when modeling the fixture; it allows features to slide (nonlinear) on the PCB surface, or loose contact just like they could in an actual fixture.

### Results of the 3D FEA



The above 3D FEA clearly pin points elevated strain levels above 1700 $\mu$ s. These results were higher than the customer's limit of 500 $\mu$ s. CCI re-engineered the fixture's PCB support system **during** the fixture **design process** and the FEA was rerun with **better results**.

### Results of 3D FEA after design modifications



Strains were significantly reduced across the entire board by increasing the number of pushdown fingers and adding pushdown blocks over the connectors. Strains fell below the customer's limits in all places on the board.

**Strain Gage Testing** is the actual measurement of strain on discrete points on the PCB while actuating the test fixture. Measurement is taken from sensors called "rosettes" that are mounted to the PCB. A scanner is connected to the rosettes that can take measurements from 2,000 to 10,000 cycles per second.

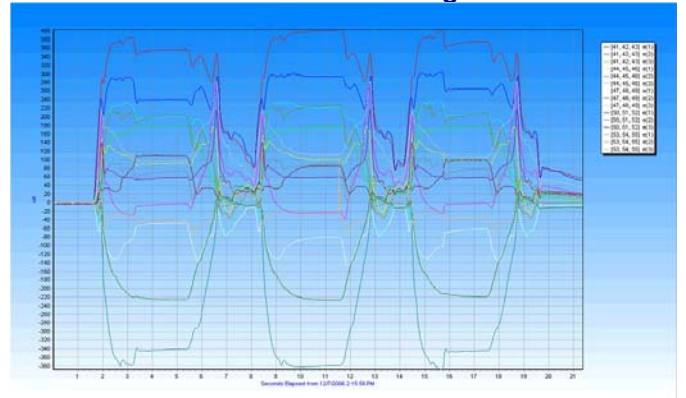
Components may have to be removed to permanently mount the rosettes to a mechanical sample of the PCB.

### Correctly mounted rosettes



In this sample test the initial results of the strain gage test indicate levels above 1100 $\mu$ s, which are unacceptable by industry standards. After mechanical modifications to the fixture's pushdown and support structure were performed a second strain gage session was performed.

### Results of final Strain Gage Session



After fixture modifications, strain gage results are below 400 $\mu$ s which are well within the current IPC/JEDEC 9704 standards.

**When should 3D FEA or strain gage be performed?**

- If the PCB is = < 0.062" w/moderate probe population.
- Densely populated, high node count boards.
- Mission critical products where failure is not an option in the field.

A fully detailed 3D FEA or Strain Gage report is submitted for your approval prior to fixture shipment.

**CIRCUIT CHECK**

6550 Wedgwood Rd.  
Maple Grove, MN 55311  
763.694.4100

www.circuitcheck.com