

SJ BIST™ – Solder Joint Built-in Self-Test

InstaBIST™ Electronic Prognostics

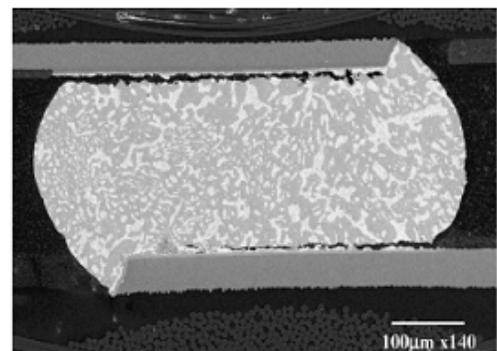
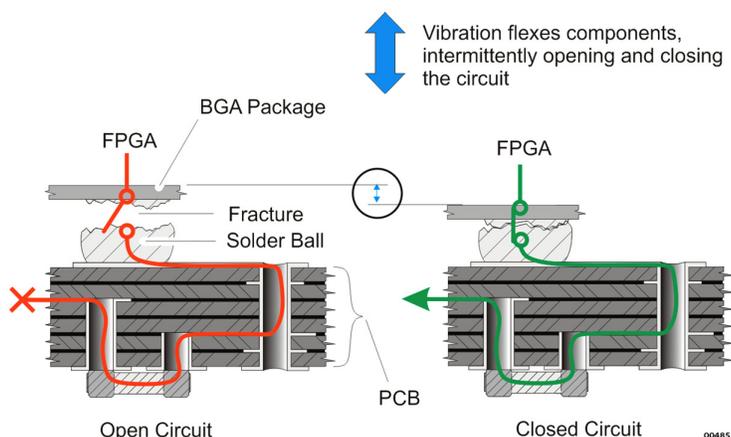


The Interconnection Prognostic Solution

- Built-in Self-Test IP Core detects incipient fatigue damage to dedicated pins of IC packages, and BGA packages in particular
- Supports interconnect reliability test and qualification
- Detects damage prior to catastrophic failure of interconnect
- Improves fault coverage without significantly increasing complexity of system
- Improves fault coverage for advanced redundancy management without using redundancy techniques
- Provides positive correlation of hardware faults to intermittencies

Solder joint connections in ball grid array (BGA) packages are especially subject to cumulative fatigue damage. Prior to development of Ridgetop's Solder Joint Built-in Self-Test™ (SJ BIST) product, there were no known methods for detecting intermittencies and high-resistance defects in functioning solder joint networks related to BGA packages. The cumulative damage eventually causes the solder joint to crack, usually at the package or printed circuit board (PCB) boundary.

SJ BIST is designed to detect static and dynamic occurrences of interconnect resistance increases and then alert the system regarding the condition of interconnect and related solder joints. Maintenance is thus facilitated, either through replacement or by switching to a redundant system prior to catastrophic failure. In addition to solder joint health monitoring, SJ BIST serves a wide range of applications where interconnect integrity and reliability are of concern.



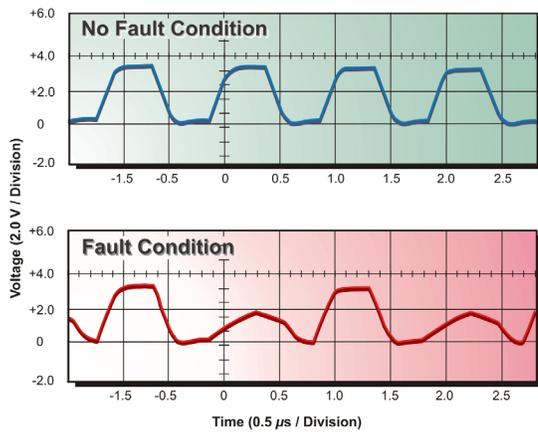
How intermittencies occur (left); photograph of a cracked solder ball on the verge of fracturing (right)

Thermal stress and physical stress are primary causes of solder joint fatigue damage. Thermal-related damage results from differences in the coefficients of thermal expansion of the materials in the IC package, solder, wiring, interconnections, and PCB, as well as from heating and cooling due to ambient temperature changes and power on-off cycling.

Physical stresses and strains result from shock, vibration, and torque forces to which the assembled PCB is subjected during missions, maintenance, and storage. The cumulative damage eventually causes the solder joint to crack, usually at the package or PCB boundary. Over time, more solder balls and other interconnection structures crack and fracture, existing fractures stay open longer, and contamination layers build up between the surfaces of fractures.

The damaged solder joints typically manifest themselves by intermittent increases (spikes) in the resistance of the network from milliohms to tens of ohms or more, and medium- to high-resistance spikes of increasing frequency and duration. As solder joint network faults tend to be intermittent in nature, they are difficult to diagnose. Often, when a removed assembly or board is examined and bench-tested, "No Trouble Found" (NTF) is the diagnosed code.

SJ BIST enables early detection and identification of an assembly likely to experience a malfunction, as shown below. The prognostic is programmed/ designed into the host circuit and a small capacitor is attached to a loop formed by one or more pairs of selected, functionally unused I/O pins, which are monitored or tested by SJ BIST.



SJ BIST two-port test, 1 MHz clock

While a particular damaged solder joint port might not result in immediate operational failure of the host circuit, the damage indicates the host circuit is no longer reliable. The occurrence of even a single fault is a prognostic warning: to avoid a near-term operational intermittent or long-lasting fault, maintenance or other mitigation is required.

The early detection possible with SJ BIST enables corrective actions using condition-based maintenance (CBM) procedures to be performed, thus avoiding operational failures.

In addition to prognostics, SJ BIST can be used in newly designed manufacturing reliability tests to investigate failure modes related to the PCB-host circuit assembly and other interconnect reliability issues.

Customer Testimonial

"SJ BIST is the first known direct in-situ measurement that is a true canary for intermittent electrical contact between bumps, PCB, and package." — German Automotive Firm

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