**What is Burn-in testing?**

Burn-in testing is the process by which we detect early failures in components, thereby increasing component reliability. In the semiconductor world, this means taking us closer to zero DPPM. During burn-in, the component is exercised under extreme operating conditions (elevated temperatures and voltages). This stresses the component under test and eliminates the “weak” population from the product prior to customer delivery.

Burn-in testing attempts to weed out failures from stage 1 of the “bathtub” curve for reliability of electronics equipment, which gives the failure rate vs. time plot of electronic components.

This curve has three stages:

- **Stage 1: Infant Mortality/Early Life** - This is the period were early failures show up in a component. These are due to lack of control in manufacturing processes at the molecular level. During this period components fail at a high rate but this rate decreases with time. (Curve in blue shows failure rate due to early fails)
- **Stage 2: Normal/Useful Life** - This is the period where rate of failure is nearly constant, and due to randomly occurring faults. (shown with green curve)
- **Stage 3: Wear Out/End of Life** - Period marked by increase in failure rate due to aging of components; this period marks the end of the useful life span of a device. These fails are due to critical paths in the device getting worn out. (Curve in red shows failure rate due to ageing).
Performing burn-in reduces the total life span of a device as shown in the below curve, but it has no impact on the useful life (Stage 2) of a device.

Advantages:

- Delivered product has higher reliability. Fewer customer returns.
- Ability to estimate the product’s useful life period.

Disadvantages:

- Higher cost (Burn-in boards degrade over time and must be replaced).
- Mechanical and EOS/ESD damage to parts.
- Non-uniform distribution of stress on device (Inability to put 100% of the device under stress).
- Efficiency of Burn-in test impacted by voltage scaling and power consumption.

Faults detected

Burn-in testing detects faults that are generally due to imperfections in manufacturing and packaging processes, which are becoming more common with the increasing circuit complexity and aggressive technology scaling. Traditional stuck-at testing does not detect these types of faults because they may be dormant and need to be stressed to manifest as “fails” (during burn-in).

The root cause of fails detected during burn-in testing can be identified as dielectric failures, conductor failures, metallization failures, electromigration, mouse-bites, etc. These faults are dormant and randomly manifest into device failures during device life-cycle. With burn-in testing, we stress the device, accelerating these dormant faults to manifest as failures.
Types of burn-in test

**Static Burn-in:** In this we apply extreme voltages and temperatures to each device without operating or exercising the device. The advantages of static burn-in are its low cost and simplicity. A major limitation of static burn-in however, is that it exercises fewer than half the circuit nodes on a device.

**Dynamic Burn-in:** Also referred to as Burn-in for Stress – in this we apply various input stimuli to each device while the device is exposed to extreme temperature and voltage. The advantage of dynamic burn-in is its ability to stress more internal circuits, causing additional failure mechanisms to occur. However, dynamic burn-in is limited because it cannot completely simulate what the device would experience during actual use, so all the circuit nodes may not get stressed.

**Dynamic Burn-in with test:** In this we additionally monitor device outputs at different points in the burn-in process, verifying that the devices are actually being exercised. This type of burn-in is especially useful for quickly determining burn-in “fallout” as a function of time, allowing the burn-in process to be terminated at an optimal point. Another advantage of burn-in with test is the ability to detect devices that will fail under marginal conditions, but not at the normal operating point. Elimination of these devices significantly improves product quality. Dynamic burn-in with test also allows devices to be tested after the burn-in cycle, eliminating the need to transfer them to a separate tester.

**Test flow**

Typical test flow for qualification of a device:

Generally, the Burn-in testing is divided into multiple stages to save of test cost:

**Stress and reliability tests**
In order to improve the reliability by screening, continuous efforts are made to have a process of accelerated tests to remove parts likely to fail, without reducing the life span of good parts. Many new processes have been developed which are used along with burn-in or can be used as alternatives.

- **ACCELERATED ENVIRONMENT STRESS TESTS**
  - PC - Preconditioning
  - Autoclave or Pressure Cooker Test
  - THB - Temperature Humidity Bias
  - HAST - Highly Accelerated Temperature and Humidity Stress
  - uHAST - Unbiased Highly Accelerated Stress
  - Power Temperature Cycling & Thermal Shock
  - HTSL - High Temperature Storage Life
  - HVST - High Voltage Stress Test

- **ACCELERATED LIFETIME SIMULATION TESTS**
  - HTOL - High Temperature Operating Life
  - ELFR - Early Life Failure Rate
  - NVM Endurance & Data Retention

- **DIE FABRICATION RELIABILITY TESTS**
  - Electro-migration
  - Time Dependent Dielectric Breakdown
  - Hot Carrier Injection
  - Negative Bias Temperature Instability
  - Stress Migration

- **ENVIRONMENTAL STRESS SCREENING**
  - Temperature Cycling
  - Thermal Shock
  - Power Cycling
  - Environmental Conditioning

**Also see:**
- [Environmental-stress screening improves electronic-design reliability](#)
- [Micro Control's burn-in system tests logic and memory devices](#)
- [High-Power Burn-In for Logic and Memory](#)