Practical Burn-in & Burn-in Time Reduction in Electronic Product Manufacturing

HK Sim

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simhkeng@yahoo.com

Abstract

Burn-in process is time consuming and costly and thus product burn-in time should be carefully studied and established to bring down the cost of manufacturing. The objective of burn-in and the common types of burn-in processes in electronic product manufacturing and their methods and equipments involved are discussed in this article.

Burn-in time reduction is always of the interest of the company to make the manufacturing process more efficient . But without proper data collection and analysis, it is very difficult to justify to management to reduce the burn-in time. Moreover, if burn-in time is not enough to remove the early failure products, the total cost of marketing this product will be expensive due to failure return and replacement cost. In this article, the writer is sharing the experiences of performing burn-in and burn-in time reduction projects in many electronic manufacturing companies . The on-going method of monitoring the quality and reliability of the product is also recommended. The objective of this article is to remove unnecessary burn-in process time without scarify the quality and reliability of the product. This will greatly reduce the cost of manufacturing and improve the time of shipment to end customer and hence the total cost of product will be minimum.

About the Author

HK Sim has more than 30 years of experience in Research and Development and high volume electronic product manufacturing in Singapore.

Product Burn-in in Manufacturing

In manufacturing processes, there is a burn-in process after the product is assembled . The aim of the burn-in test, as many people already know, is to remove infant mortality failures as shown in the Bathtub curve.

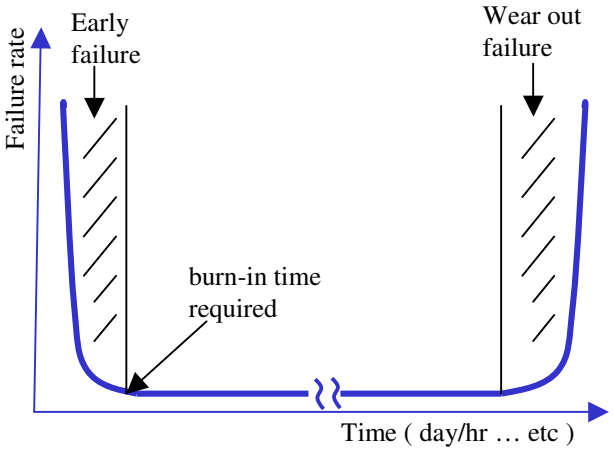


Fig 1 Typical reliability bathtub curve

The cost of manufacturing burn-in is expensive due to the following reasons :

Environmental requirement

Need environmental chambers such as temperature and/or humidity controlled oven, variable DC power supply, temperature cycle with a specific ramp up or ramp down temperature gradient. Some companies may build burn-in room for product burn-in which may not as accurate as a environmental parameter controlled burn-in oven. This type of oven or burn-in room is very expensive in order to meet the required specification.

Delay shipment to customer

Burn-in of products means products will be delay by the amount of burn-in time which means delay shipping of product to customer.

Test equipment for burn-in

Equipments for burn-in could be expensive for the case of dynamic burn-in which may involve external test equipments.

Production scheduling

Due to batch size and availability of burn-in facilities, scheduling of product for burn-in have to be more dynamic and effective. Otherwise, the manufacturing capacity will be affected due loading/unloading of products at burn-in and the cycle time of building the product will be longer.

From the eyes of business, if manufacturing burn-in process can be eliminated or reduced in time significantly, it will certainly reduce the capital investment and improve the profitability of the company.

Is Burn-in Required ?

As the purpose of burn-in is to remove early failures of product, theoretically if a product is designed for quality and reliability , the components from suppliers have the same quality and reliability from batch to batch, manufacturing process is good ,mature, stable and well controlled, you do not need burn-in.

In principal, every one of us want to be NO burn-in of product in the product manufacturing process. To achieve that, there must be no quality and reliability problem , then burn-in process can be removed. Quality and reliability starts with product design which include component qualification and design testing and when product released for manufacturing, follow

simhkeng@yahoo.com

by the quality of components by suppliers from time to time and how well the manufacturing processes is . Due to cost competition, using lower cost component (e.g. 80% of product cost is component

cost) is always a challenge to the designer without performing proper testing. Proper testing is time consuming which means approval of low cost components will take longer time by the design group which make management unhappy.

Most of the product released from design will specify certain hours of burn-in , normally from 24 hours onward.

In order to convince ourselves that the product is reliable , we need to collect data during the manufacturing burn-in process . So a good manufacturing process will have the burn-in data collected to determine the optimum burn-in time. This required the design engineering and test engineering staff to work together to provide the useful test data to decide how long it need for the burn-in process. Without the useful test data, there is no evidence to justify for the reduction of burn-in time.

Types of Burn-in processes in electronic manufacturing

There are two kinds of burn-in : static burn-in and dynamic burn-in.

Static burn-in

Static burn-in connect products to the power supply source, it could be AC or DC depends on the product designed as shown in figure 2. The product under burn-in will subject to the power for a specific number of hours and possibly, power cycle, under room temperature or elevated temperature. After the specified number of hour is reached, the product is then subject to the required functional test.

Static burn-in is simple and cost much less to implement but the disadvantage is there is no functional test data involve. Unless the product is totally not functioning after the static burn-in, you will not know whether or not the product failure after a specific number of hours and then recovers when you bring the product to room temperature for testing or its failure is intermittent in nature.

In the case of static burn-in, there is no data collected during the burn-in process to justify the reduction of burn-in time. It is based on feeling or management decision

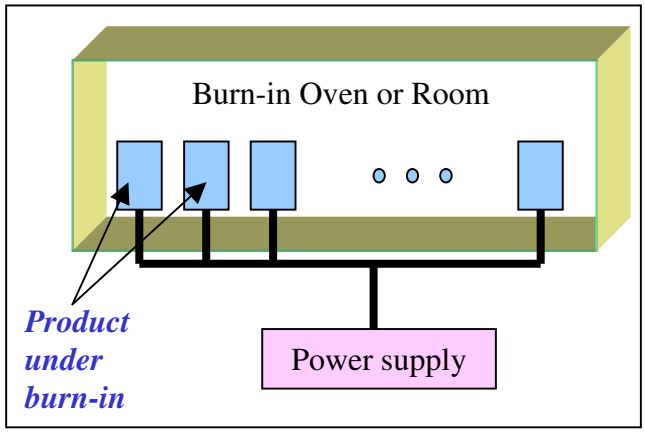
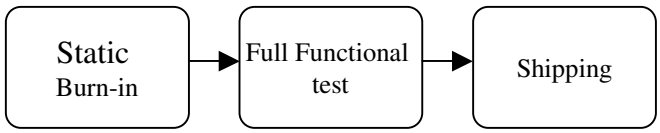


Fig 2 static burn-in



Dynamic burn-in

Dynamic burn-in collects data out from the product or test equipments during the burn-in process. It is recommended that immediately after the data collected, it should be saved in the hard disk or centralized server. Otherwise, once the PC having problem , there is no way to retrieve the data.

simhkeng@yahoo.com

Data collection out of product itself

Test data can be collected out of the product itself as shown in figure 3. This is done with self-diagnostic test on board and test data is being send out ,upon request , via serial communication or other communication interface such as USB or own proprietary standard to the host computer. When serial communication is use with RS422 interface, all the product can be connected via a pair of serial cables and thus simplified the equipment system design. The only problem with this method is you may not test with the product's application interface. This have to be test with functional test after the diagnostic burn-in.

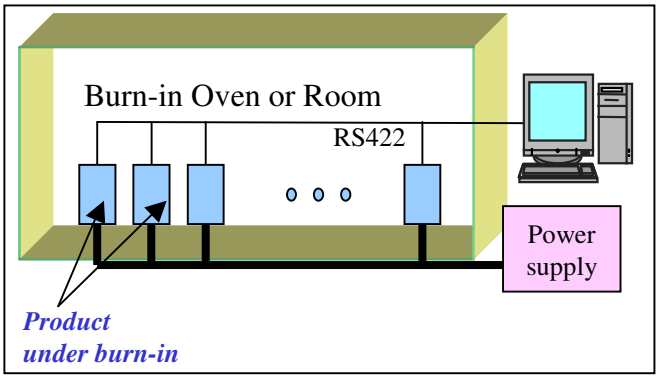
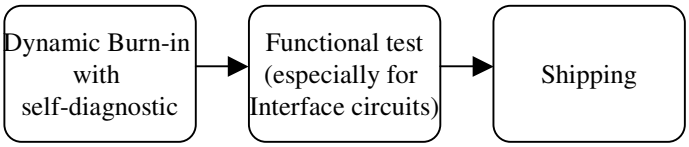


Fig 3 Dynamic burn-in with on board self-diagnostic



Data collection out of external functional test equipment

This is similar to the functional test of the product except that it is perform under burn-in environment as shown in figure 4. This kind of test is much more costly but the advantage is you may be able to ship product immediately after the dynamic burn-in . For products that does not have a microprocessor /microcontroller, this external test equipment method has to be used.

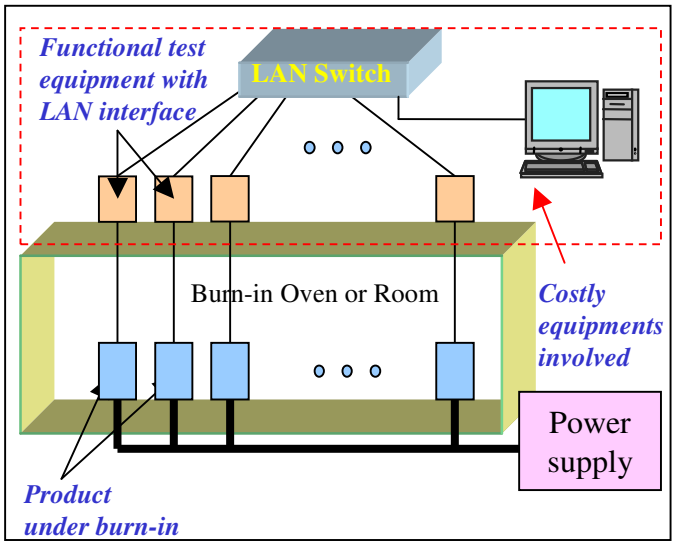
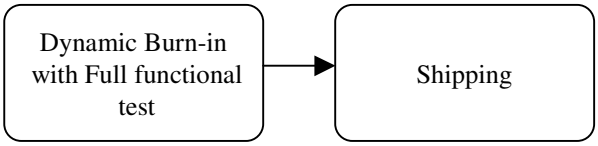


Fig 4 Dynamic burn-in with functional test equipments



Product designer's role in burn-in time reduction

In order to justify for reduction of burn-in time or eliminate the burn-in process, product designers have to work closely with test development engineers to implement test data collection system during burn-in. This is normally implemented as diagnostic firmware. The product firmware will have both operating firmware and diagnostic firmware if the memory is large enough.

In order to differentiate this diagnostic firmware from the product operation firmware, normally a jumper is inserted/removed . The intelligent device

simhkeng@yahoo.com

such as micro-controller/micro-processor will check whether or not the jumper is inserted to decide to execute the diagnostic firmware code or the operation firmware code .

As shown in figure 5, product 1,2,…, to n is operate under diagnostic mode and each product can communicate with the control computer via RS422. This the simplest dynamic burn-in test system. If a test methodology is not properly designed, you may end up with a situation that every product need a computer to control which means the test system will be very costly.

At a predefined time interval, say hourly, the control PC will send command to each product under going burn-in to request for test result. This is done by sending the product's ID and the command together. Product with the specified ID will response to the request by sending the test result to the control PC.

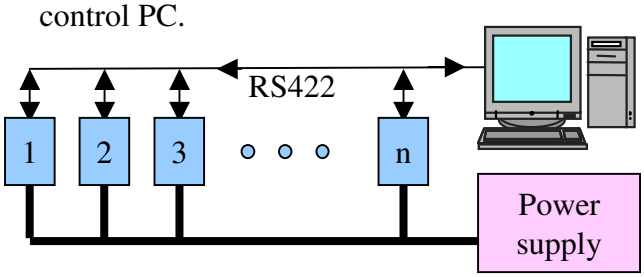


Fig 5 Simplest dynamic test

What kind of data be collected ?

The following information should be collected :

•*Location* . e.g. Oven number.

•*Environmental condition* : temperature, humidity, DC voltage, …, others

•*Product Serial number*

•*Number of burn-in cycle* – time of data collected.

•*Test result*. If fail, what is the failure mode and failure information.

•Other information that may help in manufacturing

Depending on the situation, some of the data information can be provided by the control PC/software (e.g. number of cycle which in terms determine burn-in time) to minimize the data communication between the product and control PC.

The most important data

The most important data in determine the burn-in time requirement is the true failure data. The definition of a true failure is a failure that it is verified. It could be a permanent failure or a failure that occurs only at a specific condition.

Permanent failure

This type of failure , once failed, will not become pass at other condition. For example, a product may fail at the 3rd cycle . After it failed, when it is remove to room temperature for analysis, it still remain as failure.

Non-permanent failure

This type of failure will pass at other condition. For example, a product may fail at the 6th cycle . When the product is removed for failure analysis at room temperature, it passes at room temperature The failure analysis need to verify the reject at the condition that the product failed. Some of the product may failed power supply margin, that is, for a power supply of 5 volts, it may fail at 4.75V or 5.25V. Some of the product passed at elevated temperature but fail at cold temperature. Therefore , it is very important for in a dynamic burn-in process to automatically capture the burn-in condition, be it an environment condition , time condition or test condition

simhkeng@yahoo.com

The non-permanent failed product must be analyzed with care in order to repeat the failure. Otherwise, a wrong decision may be reached.

It is recommended that experienced engineers should be deployed to handle the failure analysis.

Determine the burn-in time

The burn-in time should be the time which beyond that, no true failure occurs. It is recommended that before products put into burn-in, it must be functionally tested to make sure they passed the test before burn-in. The environmental condition , e.g. temperature , must be monitored to determine the time to reach the testing condition (e.g. 0.5 hours) . When all conditions are stabilize, the product burn-in cycle should then starts.

Burn-in of product or equipment ?

Bear in mind that we are burn-in the product and not equipments that we use for burn-in. Test equipments involve in the burn-in must be in room temperature. The equipments used must be in working condition through out the whole burn-in process. Otherwise, it is very difficult to determine whether it is product problem or equipment problem.

Monitoring of on-going reliability of product

After deciding the burn-in time or no burn-in for a product, it is very important to perform on-going reliability test to monitoring the performance of the product. This will determine whether or not the product meet the guaranteed years of service . If there is problem discovered during the on-going reliability test, the engineering team will have to decide how to take collective action to resolve the problem such as screen the failure through other test in manufacturing , disqualify the problem component supplier , make improvement on product design if the initial design is not robust or increase the burn-in time at manufacturing till the problem is resolved … etc.

Conclusion

In conclusion, product designer specified a certain duration of burn-in when a product is initial released. Manufacturing should monitor the burn-in result to determine the burn-in time required for the product. Burn-in is a tedious and costly process. Without doing dynamic burn-in with carefully designed data collection and true failure analysis capability, there is no basis to perform burn-in time reduction.

simhkeng@yahoo.com