Life Test for Product Qualification

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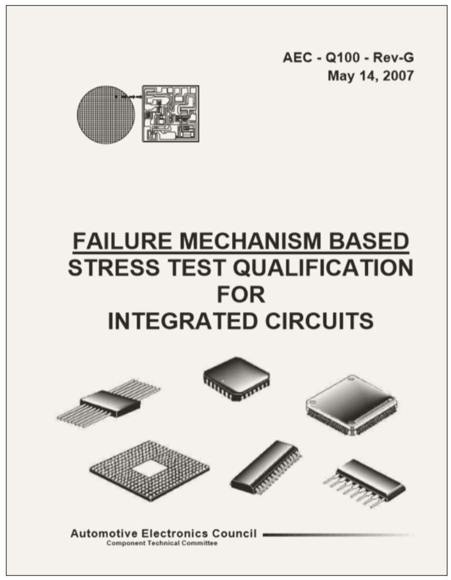
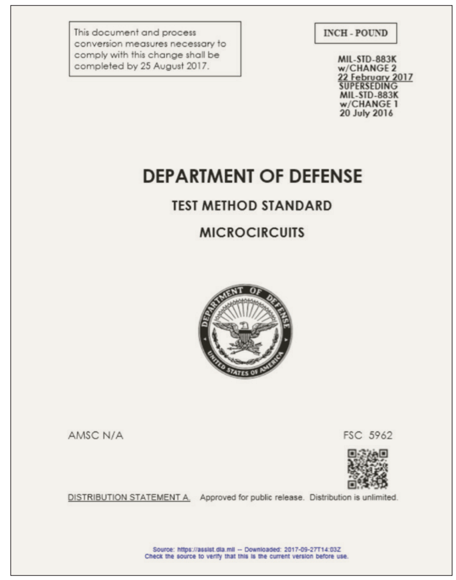
IN A PREVIOUSLY PUBLISHED ARTICLE "Environmental Test Strategies for New Product Development", the design of testing strategies for a successful product launch was discussed. But several readers pointed out that article neglected to highlight the purpose and goals of life test in general. The purpose of conducting "life test" on a product planned for or in production is simple—life testing is intended to simulate at an accelerated pace the conditions that the product is likely to experience when it is placed in service. The challenge is to simulate life conditions and conduct the testing in the shortest period of time possible to achieve production launch. For example, if the part is designed to survive a minimum of 5 years in service exposed to adverse conditions under the chassis of a heavy truck, a test must be designed to meet production launch of less than a year but simulate five years of adverse real life conditions that the product would experience. So how do we compress 5 years of service in a single year of testing or less? Frequently, publicly available test standards are available that call out the test conditions and durations. In some cases, the product manufacturer will develop a custom test standard of their own that has been fully qualified and accepted by their customers. And often times, a customer purchasing the parts or components will develop a test standard that the manufacturer must follow. In all of the cases, regardless of the test standard being used, the goal is to demonstrate that the devices under test (DUT) meet or exceed the minimum requirements of the governing test standard. And the assumption that we make when performing these tests is that the test standard accurately as possible simulates the harshest life cycle conditions that the product will face in service - no more and no less. Although an example of standards that may be used for products serving the heavy truck industry was mentioned, keep in mind that there are many different market segments that all have unique and different standards that apply.

The challenge is to condense some period—the intended design life of the product—into a time frame that will support customer demand which is typically one year or less of testing. In most situations, it is not a single test, but


AEC - Q100 - Rev-G
May 14, 2007

FAILURE MECHANISM BASED
STRESS TEST QUALIFICATION
FOR
INTEGRATED CIRCUITS

Automotive Electronics Council
Component Technical Committee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MIL-STD-883K
w/CHANGE 2
22 February 2017
SUPERSEDING
MIL-STD-883K
w/CHANGE 1
20 July 2016

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD
MICROCIRCUITS

AMSC N/A FSC 5962

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Automotive Electronics Council standards (AEC), AEC-100 and Mil Std 883.

a series or battery of tests that will ultimately demonstrate that the DUT will survive all of the product design requirements for the planned life cycle of the product. In the case of a truck chassis, it may be 3000 thermal cycle of +125° to -40°C combined with possibly ice dunk test, and many others as well. Some may be concurrent and some may be combined. These tests must simulate to the best degree possible all life conditions, from service in the desert to service in the polar regions if that is the intended application of the part, such as a vehicle component.

Test standards vary widely depending on the purpose. If there is a commercially available standard, it takes some of the work out of qualification. As a microelectronics supplier, we are sometimes required to comply with such available standards as Automotive Electronics Council standards (AEC), AEC-100 or Mil Std 883 to mention some here. But often our customers have standards written by their customers, and in other cases the customer has prepared and qualified a test standard of their own. Most importantly, it is necessary to fully understand the product qualification needs as early as possible in the process so that it can be built into the overall development plan thus achieving a successful launch. Test timing is a very critical element of the overall product development cycle. If a test sequence is going to consume four to six months of development time, then it needs to be factored in up front during the planning phase.

Often times I get asked, "How many devices (n) should I place on test?" Most often the test standard being used governs, or at least recommends, an appropriate (n) of parts. And suppliers / customers that have their own developed standards govern the number of parts required for product qualification. However, having a clear strategy in conjunction with the requirements is always helpful. As a strategy, we always recommend that the customer place more devices on test than what is required for the test standard acceptance criteria. The reason for this is quite simple. If the test requires an (n) of thirty DUT, then I would recommend placing thirty-five devices minimum on test. The reason for this is logistical. Let's say you are running a 3000 cycle thermal cycle test with DUT function test every 100 cycles. This could easily be a four or six-month test. And if you have a part failure four months into testing, the testing can continue while the part is being evaluated and root caused. And if the part failure had nothing to do with the testing (eg., technician damaged the part), then the testing can be completed

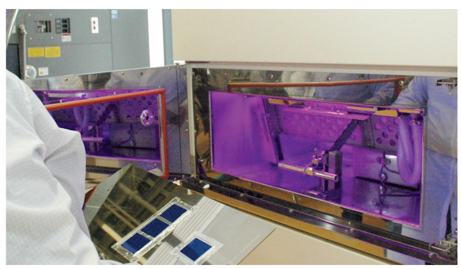
Environmental Life Test

SILICON Heartland
OH
SMART MICROSYSTEMS™

Product Validation Test Plan																										
		Results		Dur.	Pre	Post	Visual	# of	Weeks																	
Section	Test	Pass	Fail	Days*	Function	Function	Insp.	Parts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Test	**Functional Tests**																									
1	Function Test (Leak, Characterize, Insulation Resistance)			1	Yes	Yes	No																			
2	Function Test			1	Yes	Yes	No																			
3	Characterization			1	Yes	Yes	No																			
4	Presure Cycle Test			1	Yes	Yes	No																			
	Environmental Test Requirements for Product Verification																									
5	Humidity Cycling			30	Yes	Yes	No																			
6	Salt Spray Fog (144h @ DIN 50 021 SS)			8	Yes	Yes	Yes																			
7	Heat Soak			91	Yes	Yes	No																			
8	Cold Soak			91	Yes	Yes	Yes																			
	Thermal Loading and Endurance																									
9	Thermal Shock Ttest (200 cycles)			10	Yes	Yes	No				SEQUENTIAL TEST															
10	Extended Thermal Shock (1000 cycles)			50	Yes	Yes	No				SEQUENTIAL TEST															
11	Endurance Test			40	Yes	Yes	No																			
12	Stepped Temperature Test			2	Yes	Yes	No				SEQUENTIAL TEST															
13	Ice Water Shock Test (100 cycles)			4	Yes	Yes	Yes				SEQUENTIAL TEST															
	Misc																									
14	UV Testing			5	No	No	Yes																			
15	HAST Testing			1	No	No	Yes																			

on schedule and you still have the minimum required parts under test. Keep in mind that the real cost is mostly in the machines and labor, and that extra parts would likely be cost-neutral. It is certainly less costly than starting over.

At SMART Microsystems we are a microelectronics assembly supplier, so we have exposure to many different assembly parts from a wide variety of market segments: medical, oil and gas exploration, alternative energy, aerospace, communication, military, satellite / space, and automotive to name a few. Each of these market segments have their own set of life test standards because the end applications are unique and different for each of them.



SMART Microsystems' Super Ultraviolet (SUV) Accelerated Test Chamber is one of only three in the U.S. providing access to a unique and valuable capability.

Life test equipment is the final element. Some testing is so frequent and common that test equipment for that testing is commercially available. There is a lot of very high quality commercially available test equipment for some life testing. Thermal cycle and thermal shock test chambers are readily available off the shelf from multiple suppliers. Super Ultraviolet (SUV) accelerated sunlight exposure chambers are also available, but in short supply. And for some tests the only choice is to build a custom test chamber or perform the test manually. Recently we performed an ice dunk test for a customer to simulate an electronic module at an ambient temp of >150°C getting immersed in a salt ice water solution. So in this case it would not make financial sense to build a chamber for such an infrequent test, so it was performed for them manually. Life test in general can be a costly, time consuming endeavor so a little planning up front can pay big dividends in the overall product development life cycle.

If you would like a copy of the companion article or any previous articles feel free to contact the author Bill Boyce, Engineering Manager, SMART Microsystems, Bill@smartmicrosystems.com ◆

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