

Weathering Testing for Electronic Components

IEC 60068-2-5

电子产品的光老化测试

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Testing Electronics



Background

IEC 60068-2-5 (1975)

First Solar Simulation Test for Electronics

该标准是电子产品最早的阳光模拟测试

1. Object

To determine the effects (thermal, mechanical, chemical, electrical, etc.), produced on equipment and components as a result of exposure to solar radiation under the conditions experienced at the surface of the earth.

IEC 60068 (IEC 68)

Broken into 3 parts:

- IEC 60068-1: *General and Guidance*
- IEC 60068-2-X: *Tests*
- IEC 60068-3-X: *Supporting Documentation*

IEC 60068 -2

Environmental Testing of Electronics

电子产品的环境测试

- Series of standards designed to help with environmental testing of electronics

包含一系列的环境测试规程

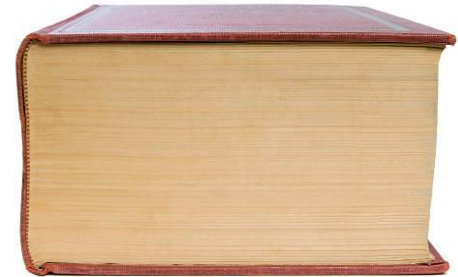
- Cover dozens of topics, including temperature, vibration, impact, salt mist, and weathering

覆盖了温度，振动，冲击，盐雾和光老化测试

MIL-STD-810

Environmental Engineering Considerations & Laboratory Tests 环境工程考量和实验室测试

- Similar to IEC 60068, this is a series of physical/environmental tests to be performed on the component/product level for electronics.
类似于IEC 60068，对于产品部件级别的环境测试
- Only 1 standard*



**1089 pages*

MIL-STD-810C Method 505.1 (1975)

Purpose. *The sunshine test is conducted to determine the effect of solar radiation energy on equipment in the Earth's Atmosphere. For the purpose of this test, only the terrestrial portion of the solar spectrum is considered...*

阳光模拟测试为了考察在地表大气中阳光辐射到设备上的影响。这个测试的目的，仅仅是考虑到达地表的太阳光谱。

Limitations

局限性

- While these tests were primarily designed for thermal loading, many used this test to simulate degradation
尽管这些测试开发之初主要是为了热载荷，但还是被用于光老化测试
- As specified, UV light was not highly controlled, compared to the full spectrum
紫外波段并没有特别去控制，相比于全光谱

DIN 75220

Ageing of Automotive Components in Solar Simulation Units

在阳光模拟箱中汽车零部件的老化

- Related to, but not the same as IEC and MIL-STD

和IEC 和MIL有关联

- Designed specifically for automotive components

特别针对汽车部件开发

- Uses a similar spectrum for daylight test, but also has more extreme nighttime conditions

主要模拟户外阳光，也有很多夜晚的模拟测试

Temperature vs. Durability Testing

温度 vs 耐久性测试

- Electronics have different end-use requirements, so the significance of these simulation tests varied.

电子器件最终使用环境不同，所以这些模拟测试的意义不同

- Thermal Loading 热老化
- Degradation 光老化

Forces of Weathering

光老化因素

Sunlight

光



Heat

热



Water

水



Which of these are going to be applicable to this product?

Procedures

MIL-STD-810 Method 505

- Procedure I
 - *Temperature* 温度
- Procedure II
 - *Actinic Effects* 光致反应

IEC 60068-2-5

- Sa 1 – Temperature
- Sa 2 – Temp & Durability
- Sa 3 – Durability
- Sb 1 – Weathering
- Sb 2 – Weathering
(behind glass)

Challenges and Test Tailoring

挑战和测试剪裁

Challenges to these Methods

- Solar Thermal Loading puts an emphasis on longwave visible and infrared (IR) radiation

热老化测试更关注长波段如可见光和红外线

- Most weathering tests do not control the IR range, and lamp aging can cause fluctuation

大部分的光老化测试不控制红外部分，灯管老化会导致红外增加

Table 505.5C-I. Spectral energy distribution and permitted tolerance

Spectral Region	Bandwidth (nm)	Natural Radiation (% of total)	Tolerance (% of total)		Irradiance (W/m ²)	Spectral Region Irradiance (W/m ²)
			Min	Max		
Ultraviolet - B	280-320	0.5	0.3	0.7	5.6	5.6
Ultraviolet - A	320-360	2.4	1.8	3	26.9	62.7
	360-400	3.2	2.4	4.4	35.8	
Visible	400-520	17.9	16.1	19.7	200.5	580.2
	520-640	16.6	14.9	18.3	185.9	
	640-800	17.3	12.8	19	193.8	
Infrared	800-3000	42.1	33.7	50.5	471.5	471.5
Totals					1120	1120

Test Tailoring

测试剪裁

In order to compensate for many different tests for many different specimens, a test may be tailored based on the equipment available and the parameters of interest

根据不同产品的实际测试要求，和现有设备的功能，测试可以剪裁以符合测试的关注点

(MIL-STD-810 Part 1 and IEC 60068-1)

MIL STD 810 on Test Tailoring

The primary emphases are... tailoring a materiel item's environmental design and test limits to the conditions that the specific materiel will experience throughout its service life, and establishing laboratory test methods that replicate the effects of environments on materiel, rather than trying to reproduce the environments themselves.

关键是需要对测试材料在实际服役环境中经受的环境状态和测试限制条件进行剪裁，制定相关的实验室测试方法以复制环境因素作用于材料的影响，而非复制环境本身。

MIL STD 810 on Test Tailoring

It is important to emphasize that...these methods are not to be called out in blanket fashion, nor applied as unalterable routines, but are to be selected and tailored to generate the most relevant test data possible.

这些方法不能被笼统地调用，也不能不做改变地应用，而是应该选择加以裁剪尽可能地产生相关的测试数据。

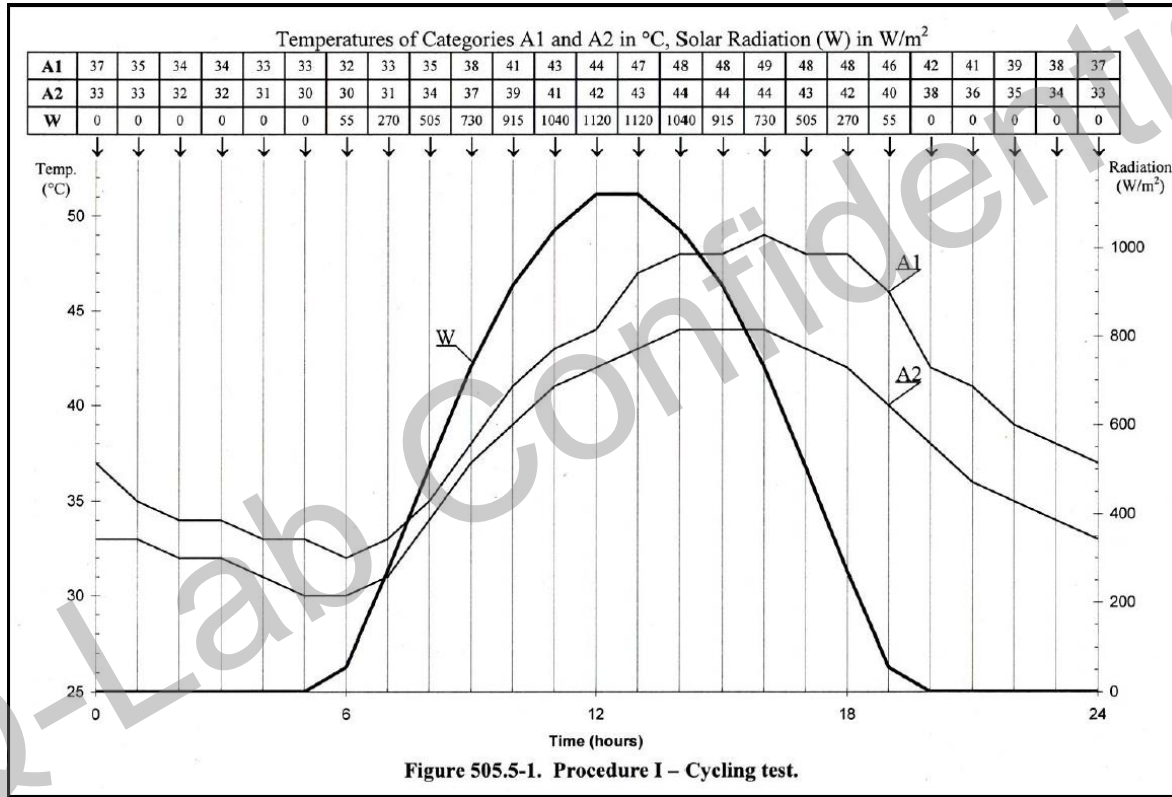
Based on this and other language in the standard, Q-Lab believes that Xenon Arc testing with controlled UV produces the best method of replicating real-world effects
根据以上和标准的精神，Q-Lab认为氙灯很好地模拟紫外，能最好地重现户外的老化现象

Tailored Q-SUN Filters/setpoints

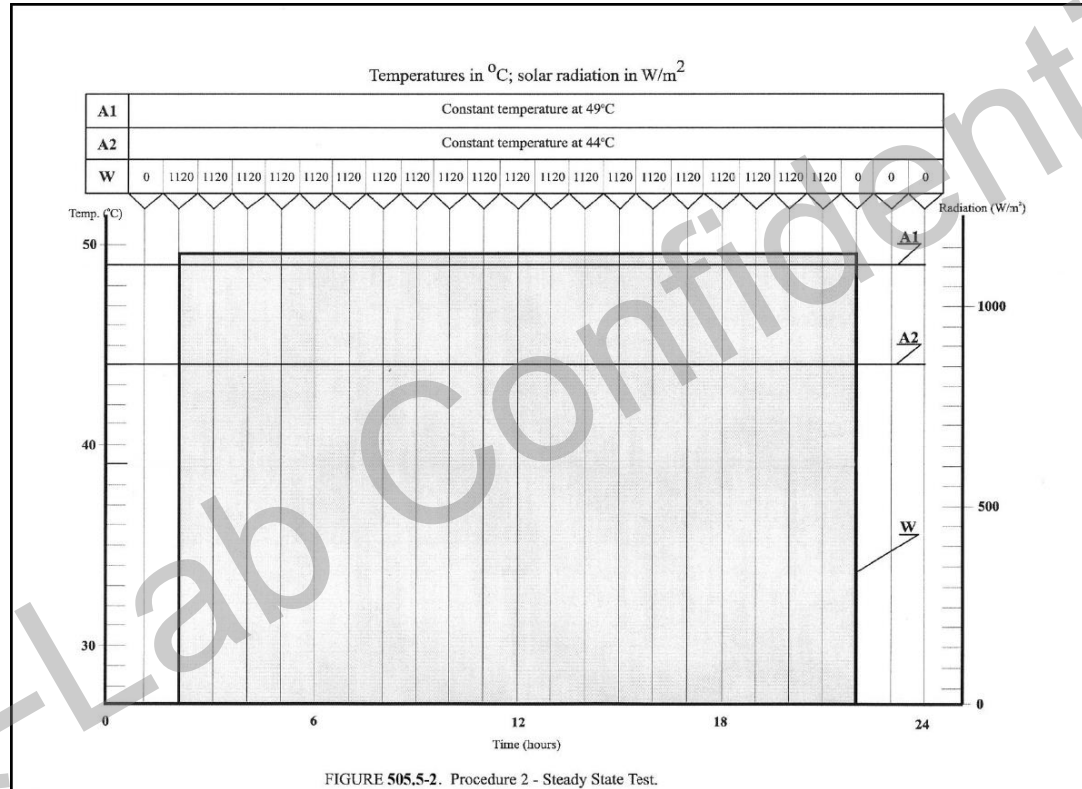
Spectral Region	Bandwidth (nm)	Table 1 Irradiance Specification (W/m ²)	Table 1 Irradiance Specification (%)	Spectral Region Irradiance: Q-SUN with Daylight-B/B filter at 0.60 W/m ² /nm @ 340nm (W/m ²)	Spectral Region Irradiance: Q-SUN with Daylight-Q filter at 0.68 W/m ² /nm @ 340nm (W/m ²)	Spectral Region Irradiance: Q-SUN with Daylight-F filter at 0.75 W/m ² /nm @ 340nm (W/m ²)
Ultraviolet - B	280-320	4.06	0.4	4.3	2.6	3.9
Ultraviolet - A	320-360	70.5	6.4	23.7	26.6	29.4
	360-400			36.7	45.1	45.6
Visible	400-520	604.2	55.4	147.6	182.9	183.9
	520-640			137.9	171	171.3
	640-800			157.5	195.4	196.0
Infrared	800-2450	411.2	37.8	771.2	957.1	956.8
Total	280-2450	1090	100	1279	1580.7	1586.9

Test Cycles

MIL STD 810 505.5 – Procedure I



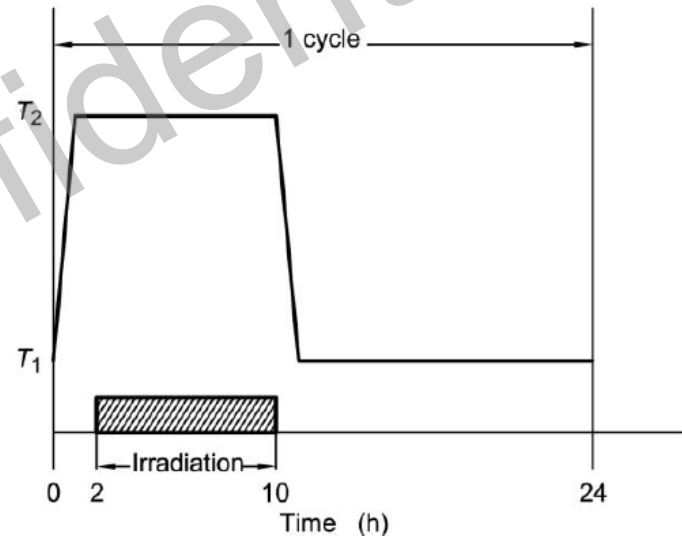
MIL STD 810 505.5 – Procedure II



IEC 60068-2-5 Cycles: Sa1

- Sa 1 – Diurnal Cycle
 - 8 hours of light, 40 °C (air)
 - 16 hours of darkness 25 °C
- Used for **thermal cyclic testing**
用于热循环测试

Procedure Sa 1



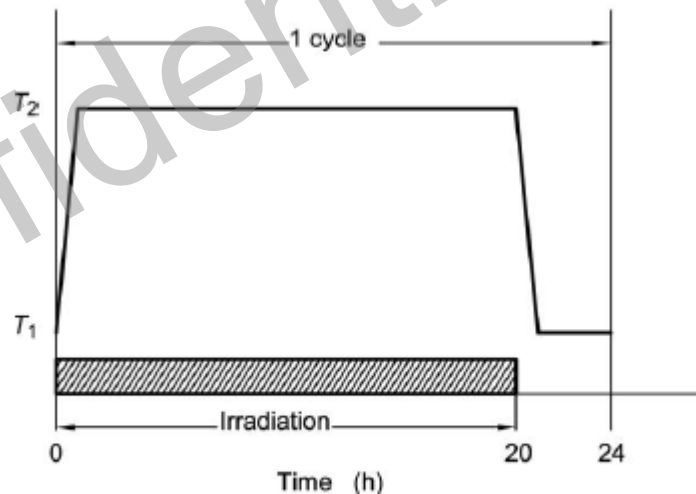
a) Procedure Sa 1

IEC 60068-2-5 Cycles: Sa 2

- Sa 2 – Extended Light
 - 20 hours of light, 40 °C (air)
 - 4 hours of darkness 25 °C
- Used for testing **degradation effects**

用于材料老化

Procedure Sa 2



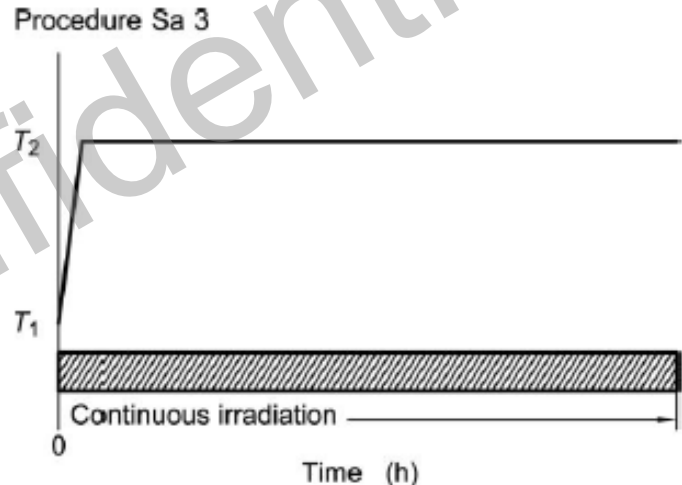
b) Procedure Sa 2

IEC 60068-2-5 Cycles: Sa 3

- Sa 3 – Continuous Light
 - 24 hours of light
 - 40 °C (air)

- Used for testing only **photochemical effects**

用于光致反应



c) Procedure Sa 3

IEC 60068-2-5:2018

Weathering

- In 2018, specific **weathering** cycles were added for users interested in full weathering testing
光老化测试被加入标准以满足材料光老化测试的需求
- For those familiar, these are the same cycles and filter definitions found in ISO 4892-2 (Xenon Arc Weathering of Plastics)
引用了ISO 4892-2（塑料氙灯测试方法）中的测试条件

IEC 60068-2-5 Weathering Cycles

Table 5 – Exposure cycles

Procedure Sb 1 – Exposure cycle using daylight filters with wetting						
Exposure period	Irradiance ^{a b}		Temperature ^c		Chamber temperature °C	Relative humidity % ^d
	Broadband (300 nm to 400 nm) W/m ²	Narrowband (340 nm) W/(m ² × nm)	Black standard temperature °C	Black panel temperature °C		
102 min dry	60 ± 2	0,51 ± 0,02	65 ± 3	63 ± 3	38 ± 3	50 ± 10
18 min water spray	60 ± 2	0,51 ± 0,02	–	–	–	–
Procedure Sb 2 – Exposures using window glass filters without wetting						
Exposure period	Irradiance ^{a b}		Temperature ^c		Chamber temperature °C	Relative humidity % ^d
	Broadband (300 nm to 400 nm) W/m ²	Narrowband (420 nm) W/(m ² × nm)	Black standard temperature °C	Black panel temperature °C		
Continuous Irradiation	50 ± 2	1,10 ± 0,02	65 ± 3	63 ± 3	38 ± 3	50 ± 10

Specimen Mounting

样品的安装

Specimen Mounting

样品安装

- Many weathering tests are performed on plaques, painted panels, or prepared specimens

许多光老化测试制成小样板/样件进行测试

- However, for methods like IEC 60068-2-5 and MIL-STD-810, these tests are usually run on finished components/products

IEC和MIL标准通常是针对最终的部件进行测试

- Mounting three-dimensional (3D) specimens can cause issues with thermal and irradiance uniformity

安装三维异样件可能产生热和辐照均匀性的问题

Specimen Mounting Tips

样品安装小贴士

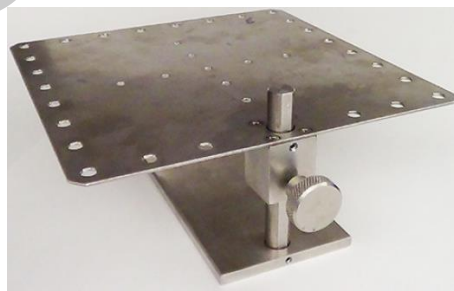
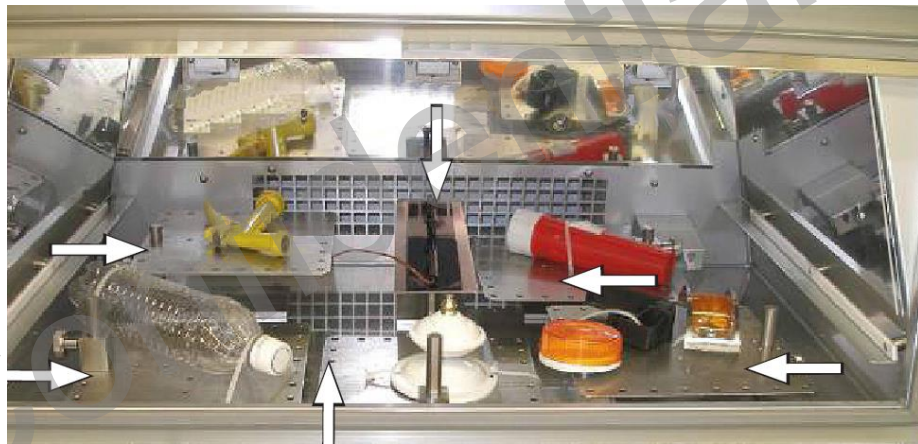
- Avoid putting large specimens too close to the lamps
样品与灯管距离不能太近
- Put the surface of most interest facing the lamps
关心的那面朝着灯管，就是测试面
- Avoid backing flat parts with insulating materials
避免在平整的样品背面使用绝缘材料做背衬
- Specimens can be hotter than the black panel!
样品的温度可能会超过黑板温度

3D Specimen Holders

3D样品架

3D specimen holders can be used to maintain proper distance from lamps

3D样品架可以保持样品与灯管合适的距离



Conclusions

- Electronic testing often brings some weathering & lightfastness challenges

电子产品的老化测试具有挑战性

- Identify the common use for a component, and decide if solar thermal load or weathering is more important

确认产品是偏重做热老化还是光老化测试

- Utilize test tailoring to give you a more realistic result by customizing these tests

使用裁剪制定更符合需求的测试

- Take care to utilize proper specimen mounting techniques for 3D specimens.

使用正确的方式安装3D样品

Questions?



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- ✓ 老化及腐蚀技术文章、最新测试标准解读等
- ✓ 相关技术问题，也可通过平台留言，我们会在24小时内和您联系

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