Weathering Testing for Electronic Components

IEC 60068-2-5

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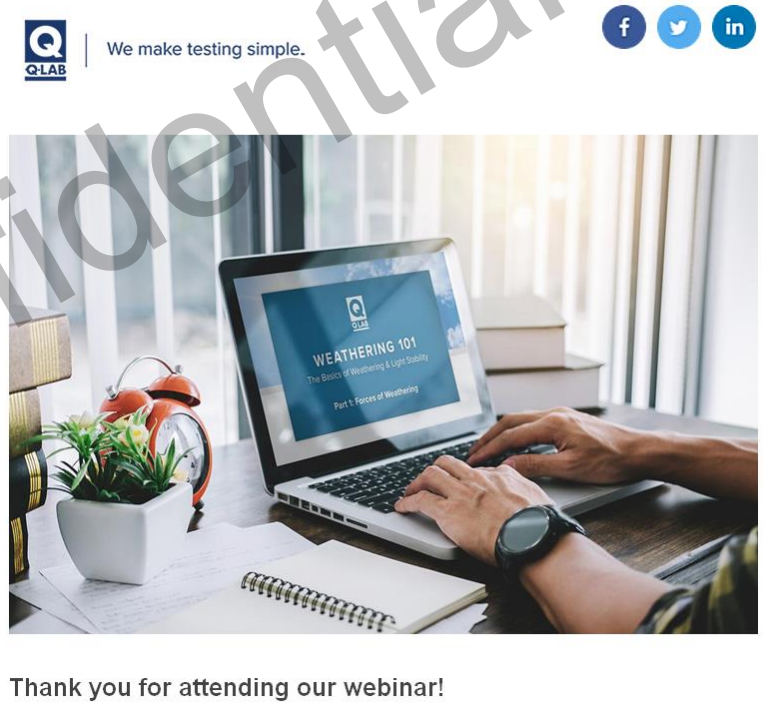


Testing Electronics

Background

- IEC 60068-2-5 (1975)
  First Solar Simulation Test for Electronics

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)
Environmental Testing of Electronics

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

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

IEC 60068 (IEC 68)

- Broken into 3 parts

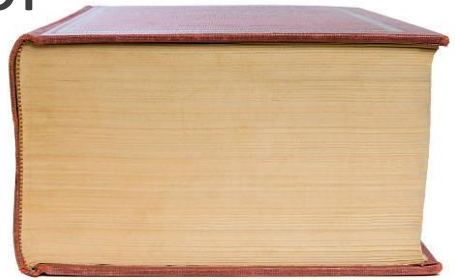
- IEC 60068-1: General and Guidance
- IEC 60068-2-X: Tests
- IEC 60068-3-X: Supporting Documentation

MIL STD 810

Environmental Engineering Considerations and Laboratory Tests

- Similar to IEC 60068, this is a series of physical/environmental tests to be performed on the component/product level for electronics.

- 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…*

Fist Iteration Testing

- These tests were limited based on the equipment available at the time
  - Mercury Vapor Lamps
  - Carbon Arc Lamps
  - Xenon Arc Lamps
  - Multivapor lamps

Limitations

- While these were primarily designed for thermal loading, many used this test to simulate degradation
- As specified, UV light was not highly controlled compared to the full spectrum

DIN 75220

Ageing of Automotive Components in Solar Simulation Units

- Related, but not the same as IEC and MIL STD
- Designed specifically for automotive components
- Uses a similar spectrum for daylight test, but also has more extreme nighttime conditions

Temperature vs. Durability Testing

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

Forces of Weathering

Sunlight

Heat

Water

Which of these are being tested by these methods?

Procedures

MIL STD 810 Method 505

- Procedure A
  – Temperature
- Procedure B
  – Actenic Effects

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

Challenges to these Methods

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

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

Table 505.7-I. Spectral power distribution.

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

NOTE: The amount of radiation wavelength shorter than 300 nm reaching the Earth's surface is small but the effect on the degradation of material can be significant. Short wavelength energy below 300 nm can cause materials to fail unnecessarily (if not present in the natural exposure). In reverse, if energy below 300 nm is present in the natural environment and not present in the accelerated exposure, material that should fail may pass the test. This is entirely material dependent because it relates to the end use in natural exposure. Values in the above table have been taken from DIN 75220. (See Annex A, paragraph 2.2.)

Test Tailoring

- 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

(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.

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.

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

Tailored Q-SUN Filters/setpoints

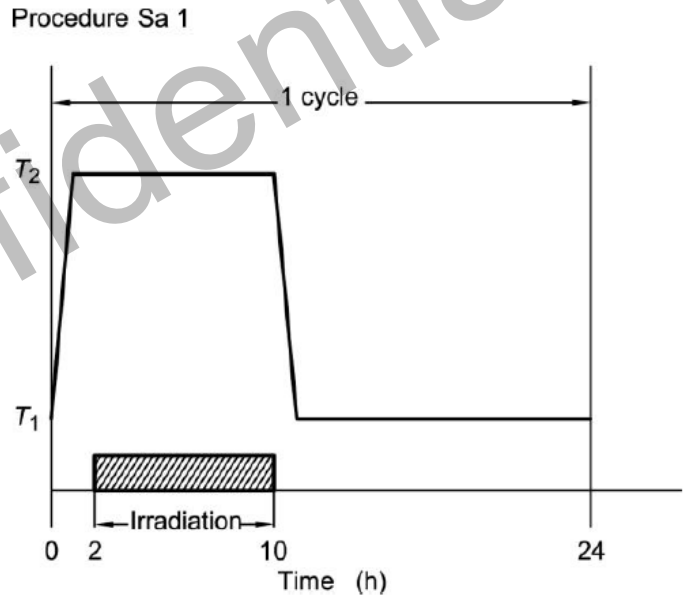
Spectral Region	Bandwidth (nm)	Table 1 Irradiance Specification (W/m^2)	Table 1 Irradiance Specification (%)	Spectral Region Irradiance: Q-SUN with Daylight-B/B filter at 0.60 $W/m^2/nm$ @ 340nm (W/m^2)	Spectral Region Irradiance: Q-SUN with Daylight-Q filter at 0.68 $W/m^2/nm$ @ 340nm (W/m^2)	Spectral 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

IEC 60068-2-5 Cycles

- Sa 1 – Diurnal Cycle
  8 hours of light, 40 °C (air)
  16 hours of darkness 25 °C

- Used for thermal cyclic testing

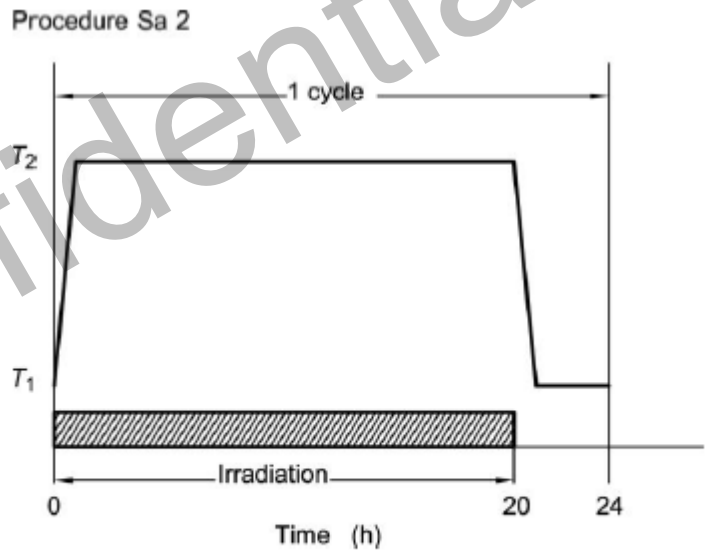


a) Procedure Sa 1

IEC 60068-2-5 Cycles

- Sa 2 – Extended Light
  20 hours of light, 40 °C (air)
  4 hours of darkness 25 °C

- Used for testing degradation effects

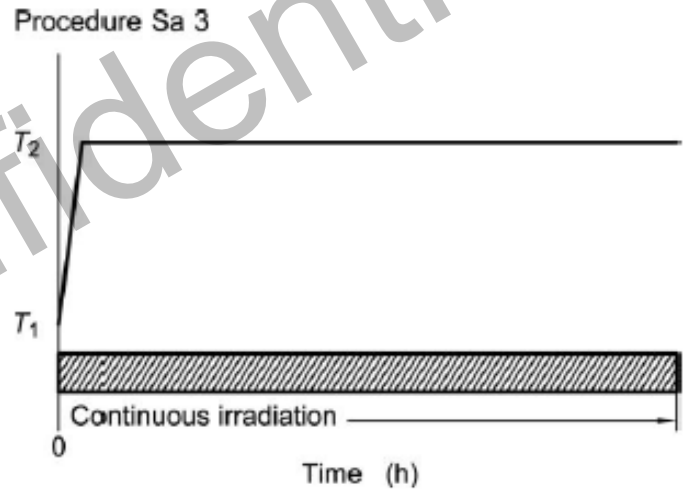


b) Procedure Sa 2

IEC 60068-2-5 Cycles

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

- Used for testing photochemical effects only



c) Procedure Sa 3

IEC 60068-2-5:2018
Weathering

- In 2018, specific weathering cycles were added for users interested in full weathering testing

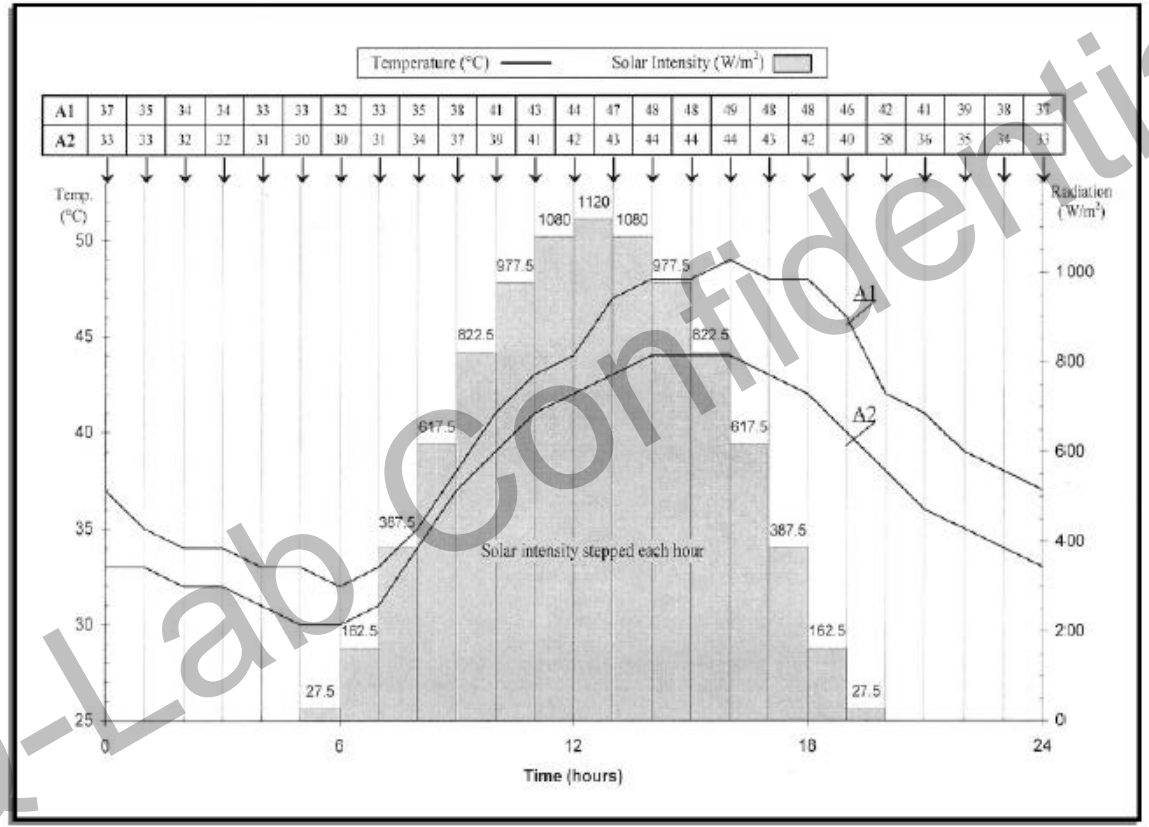
- For those familiar, these are the same cycles and filter definitions found in ISO 4892-2 (Weathering of Plastics)

IEC 60068-2-5 Weathering Cycles

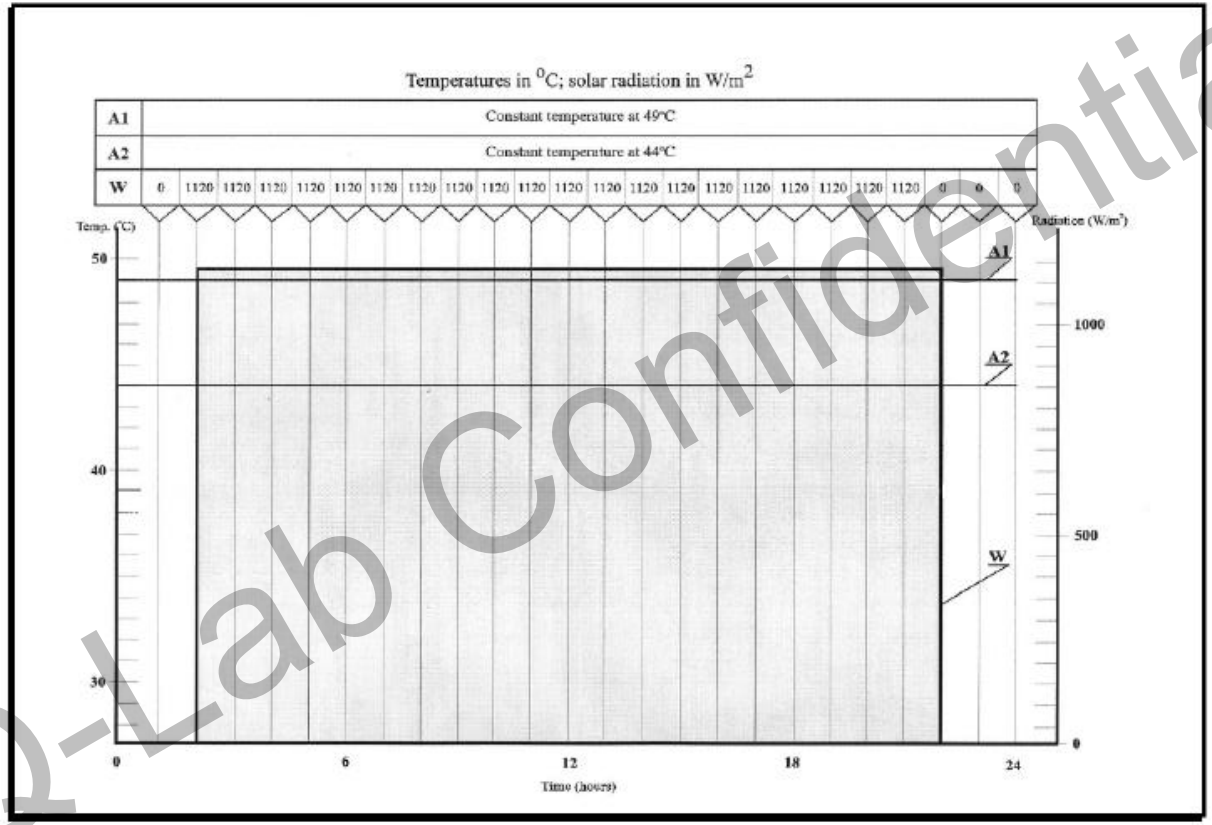
Table 5 – Exposure cycles

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/m²	Narrowband (340 nm) W/(m² × 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/m²	Narrowband (420 nm) W/(m² × 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

MIL STD 810H Procedure I



MIL STD 810H Procedure II



Specimen Mounting

Specimen Mounting

- Many weathering tests are performed on plaques, painted panels, or prepared specimens
- However, for methods like IEC 60068-2-5 and MIL STD 810, these tests are usually run on finished components/products
- Mounting three-dimensional (3D) specimens can cause issues with thermal and irradiance uniformity

Specimen Mounting Tips

- Avoid putting large specimens too close to the lamps
- Put the surface of most interest facing the lamps
- Avoid backing flat parts with insulating materials
- Specimens can be hotter than the black panel!

3D Specimen Holders

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

Conclusions

- Electronic testing often brings some weathering & lightfastness challenges
- Identify the common use for a component, and decide if solar thermal load or weathering are more important
- Utilize test tailoring to give you a more realistic result by customizing these tests
- Take care to utilize proper specimen mounting techniques for 3D specimens.

Questions?

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