Standard

Qualification and Quality Requirements for Space Solar Cells

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Abstract

This standard establishes qualification, characterization, and quality requirements for all solar cells intended for operations in space. It defines terminology and establishes standard tests, environmental conditions, procedures, and systematic methods for verifying the capability of a photovoltaic solar cell device to operate in the environment of space. This standard is intended to be used to establish the minimum level of testing required to demonstrate that a solar cell type will operate in a predictable and understood manner. Success and failure criteria are defined for each qualification test. For the characterization tests, sufficient data is collected to predict electrical performance and behavior as a function of pertinent operational and environmental parameters.
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Foreword

AIAA Standard S-111-2005, *Qualification and Quality Requirements for Space Solar Panels*, was originally developed to provide a “gold standard” for space solar cell qualification, with provisions included to supplement industry standards for quality.

In this revised version of the standard, effort and care has been taken to update, clarify and resolve controversial provisions that were present in the original. The result is a new standard that the Solar Cells and Solar Panels Committee on Standards has developed and reached consensus that defines the best practices for space solar cell qualification.

At the time of the 2014 revision, the members of the AIAA Solar Cells and Solar Panels CoS were:

- Henry Brandhorst (Chair)  Carbon-Free Energy, LLC
- Robert W. Francis (Co-Chair)  Aerospace Corporation
- Edward Gaddy (Co-Chair)  Johns Hopkins University Applied Physics Laboratory
- Amalia Aviles  The Boeing Company
- Scott Billets  Lockheed Martin Space Systems Company
- Robert Bornino  National Technical Systems
- Marc Breen  The Boeing Company
- Ben Cho  Emcore Corporation
- James Hall  Qioptiq Space Technology
- Bao Hoang  Space Systems/Loral
- Glenn Jones  Qioptiq Space Technology
- Bongim Jun  Boeing-Spectrolab
- Mark Kruer  Northrop Grumman Aerospace
- John Lyons  Goddard Space Flight Center
- John Martin  Qioptiq Space Technology
- Scott Messenger  Naval Research Laboratory
- Nikki Noushkam  Orbital Sciences Corporation
- Tod Redick  Space Systems/Loral
- Brad Reed  Consultant
- Luis Rodriguez  Space and Missile Systems Center
- Dennis Russell  Boeing Radiation Effects Laboratory
- Paul Sharps  Emcore Corporation
- Brian Smith  Aerospace Corporation
- Jared Smith  Space and Missile Systems Center
- Charles Suh  The Boeing Company
- C. M. Chantal Toporow  Northrop Grumman Space Technology
- Brian Wells  XEEL Corporation
The above consensus body approved this document for publication in June 2014. The AIAA Standards Executive Council (VP-Standards, Laura McGill, Chairperson) accepted this document for publication in June 2014.

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Introduction

The purpose for this document is to provide a high level of confidence to the community that a solar cell type is qualified for space applications, and that it is ready for qualification under AIAA-S-112A-2013 Qualification and Quality Requirements for Electrical Components on Space Solar Panels.

Bypass diodes, interconnects, covers, and adhesive are not completely qualified by this Standard. Nonetheless, any failure of these components exposed by tests required by this Standard must be reported. In addition, the qualifier must investigate the component failure, determine its cause and take corrective action. The qualifier must also evaluate the component failure with respect to its effect on the cell qualification.

The goal of this document is to standardize testing protocols within the industry that uses, builds, and performs research on space solar cells. The tests included are perceptive to problems seen both in ground testing and on-orbit, and are the first step in including a “test like you fly” protocol in the space solar cell industry. As ground rules for inclusion in this standard, tests had to have been previously documented; experimental tests were disallowed and test equipment had to be available in at least one facility. The order of test execution in this standard was set up to be as close to the sequence of solar cell and panel build, storage, integration and flight as possible.
1 Scope

This document establishes qualification and quality requirements for crystalline silicon and gallium arsenide-based single and multiple junction solar cell types for space applications. This includes requirements for solar cell manufacturer quality systems and for characterization of solar cells. Requirements for acceptance testing of lots are not defined in the current version of this document.

Qualification is required when introducing a new solar cell design. Delta qualification is required when making modifications to the materials and processes used to manufacture a qualified cell. If the materials and process changes are limited, these may be considered and evaluated for the scope of a delta qualification. The delta qualification must be based on how the changes might affect the performance and reliability of the cell. The justification for the delta qualification and a detailed description of the changes must be documented per section 11.5, Delta Qualification Report. A change to the lateral dimensions of a qualified cell type does not require delta qualification or re-qualification.

2 Tailoring

Unless otherwise specified, this document may not be tailored.

3 Applicable Documents

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. Amendments to, or revisions of, any of these documents do not apply. This standard takes precedence in the event of a conflict between it, the documents cited below, and other documents.


ASTM C1161 Standard Test Methods for Flexural Strength of Advanced Ceramics at Ambient Temperature

ASTM C1239-07 Standard Practice for Reporting Uniaxial Strength Data and Estimating Weibull Distribution Parameters for Advanced Ceramics

ASTM C1683-10 Standard Practice for Size Scaling of Tensile Strengths Using Weibull Statistics for Advanced Ceramics

ASTM E490 Solar Constant and Zero Air Mass Solar Spectral Irradiance [Notwithstanding the above, the latest version of this document applies.]


EIA 625 Requirements for Handling Electrostatic Discharge Sensitive Devices