

# UL 2579: FUSES FOR PHOTOVOLTAIC SYSTEMS

Robert Lyons, Jr.  
Product Manager

## Points of Interest:

- UL standard 2579, “Fuses for Photovoltaic Systems”, is a product standard written specifically for fuses intended to be used for photovoltaic circuit protection
- Unlike fuses listed to the general purpose standard, UL 248, fuses listed to UL 2579 are subject to additional tests, including (1) Verification of Freedom from Unacceptable Levels of Thermally Induced Drift, (2) Verification of Functionality at Temperature Extremes and (3) Current Cycling
- By definition fuses listed to UL standard 2579 are simply classified, “Photovoltaic Fuse” or alternatively under the IEC definition, “gPV”

## 1. Introduction

UL standard 2579, officially titled “Fuses for Photovoltaic Systems” was first released as an outline of investigation in December 2007. Since its inception, and with the help of many industry experts including Mersen, the standard has experienced several revisions and augmentations in response to industry technological advances and as industry experts learn more regarding the behavior of PV system electrical faults. The purpose of this paper is to educate the reader of the considerable differences between general purpose fuses and photovoltaic fuses in regards to how they are tested, certified and the impact they will have on future specifications and system installations.

## 2. Background: UL Standard 248 – Low Voltage Fuses

UL standard 248, officially titled “Low Voltage Fuses”, formerly UL standard 198, was first published in the 1990’s (UL standard 198 in the 1970’s). Its intention was to mandate fuse performance criteria in order to prevent fire hazards in typical AC and/or DC applications such as power control, power low voltage distribution and power electronics. Performance requirements such as time-delay, current-limitation, and high interrupting ratings were required for safe interruption of electrical faults.

Historically in the PV industry, specifying engineers, integrators and installers had been utilizing circuit protection components and solutions that were originally designed for AC power and control applications, listed to UL standard 248. Although these products generally performed as needed they were not necessarily the optimal solution for photovoltaic applications. UL standard 2579 is a product standard written specifically for fuses intended to be used for photovoltaic circuit protection. This standard allows users to select the proper products quickly and confidently. It also allows fuse manufacturers to obtain UL Listings on fuses that conform to the standard, even for voltages up to 1500 Volts DC, which was not possible under the general purpose standard, UL 248. Most importantly, fuses listed to UL standard 2579 will deliver improved system performance and longevity, adding to the overall value of your solar power installation.

### 3. UL Standard 2579 – Fuses for Photovoltaic Systems

As mentioned in the introduction, UL standard 2579 is an Outline of Investigation, not an official UL standard. An Outline of Investigation is a collection of requirements based upon UL's investigations of a few products and is UL's first step toward development of a proposed standard. Outlines serve as guidelines in UL's investigations for the product categories indicated. This means that it is up to either local jurisdiction or your UL inspector to either enforce this guideline or not. However, it is only a matter of time before this Outline of Investigation will be converted into an official product standard and it is recommended that you plan accordingly and consider UL 2579 Listed fuses sooner rather than later.

#### General Performance Characteristics

There are three general performance characteristics within UL standard 2579 which make it unique and unlike the general purpose fuse standard, UL 248; (1) Voltage Rating, (2) Interrupting Rating and (3) Classification.

##### a. Voltage Rating

Before the release of UL standard 2579, it was not possible to obtain UL Listings for fuse products above 600VAC/DC. UL standard 248 strictly stated that fuses can only be listed to one of its 16 sub-sections for voltages 600 and below. Fuses designed for voltages above 600 were subject to UL Recognition because it did not meet the exact requirements of the standard. UL standard 2579 allows fuses to be UL Listed up to 1500VDC which is in conjunction with the upward voltage trends of the photovoltaic market. It must also be noted that UL standard 2579 does not list fuses to AC, only DC.

##### b. Interrupting Rating

Unlike typical AC electrical systems, the available fault current of a photovoltaic source circuit is dependent on the number of PV modules installed. Typical grid-tie AC electrical systems can have extremely high fault currents because they are at the mercy of the maximum available power present on the utility grid at that time. In other words, in photovoltaic application, fault currents are already limited due to the fact that PV modules can only produce a specified amount of fault current. For this application, photovoltaic fuses must be able to interrupt faulted circuits quickly under limited fault currents. This is why UL standard 2579 specifies that photovoltaic fuses need only an interrupting rating of 10kA, as opposed to 200kA required for most general purpose fuses listed to UL standard 248.

##### c. Classification

Unlike typical fuses for AC applications, photovoltaic fuses do not require time-delay (a motor in-rush current withstand requirement), current-limitation (limits high fault currents) or high interrupting capabilities (as explained in section b). Terms such as current-limiting, time-delay, fast-acting, renewable, one-time, etc... do not apply and should not be considered when selecting overcurrent protection for photovoltaic applications. By definition fuses listed to UL standard 2579 are simply classified, "Photovoltaic Fuse" or alternatively under the IEC definition, "gPV".

#### Specific PV Fuse Performance Tests

Fuses listed to UL standard 2579 are subject to additional testing, simulating the service environment conditions of photovoltaic installations. There are three tests required by UL 2579, which are not included within the general purpose fuse standard, UL 248. Tests include; (1) Verification of Freedom from Unacceptable Levels of Thermally Induced Drift, (2) Verification of Functionality at Temperature Extremes and (3) Current Cycling.

##### a. Verification of Freedom from Unacceptable Levels of Thermally Induced Drift

Verification of Freedom from Unacceptable Levels of Thermally Induced Drift tests the fuse interrupting capabilities after exposure to numerous hot to cold climate cycles commonly experienced by components installed in photovoltaic applications. This test simulates extreme night to day climate transitions and is intended to mitigate the affects they have on fuse performance. Fuse samples undergo 50 cycles of heating and cooling, 15 minutes at -40°C followed by 15 minutes at 90°C. After being returned to room temperature fuses undergo electrical tests to verify that they still operate as intended after temperature cycling.



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## 2 — PVPN4: UL 2579: Fuses for Photovoltaic Systems

USA T 978 462 6662 F 978 462 0181 info.nby@mersen.com

CANADA T 416 252 9371 F 416 252 6572 sales.tor@mersen.com

[us-ferrazshawmut.mersen.com](http://us-ferrazshawmut.mersen.com) [ca-ferrazshawmut.mersen.com](http://ca-ferrazshawmut.mersen.com)

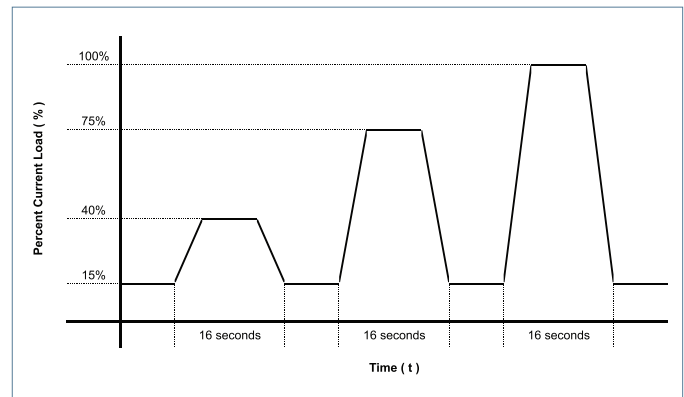


### b. Verification of Functionality at Temperature Extremes

Verification of Functionality at Temperature Extremes tests the fuse interrupting capabilities at temperatures higher than room temperature which is typical of photovoltaic installations. Commonly, PV fuses are installed in string or array combiner boxes and inverter cabinets that are located on roof tops or open areas that have direct exposure to the elements of the sun. Ambient temperatures can exceed the normal values of typical room temperatures (25°C) that fuses listed to UL standard 248 are tested to. Fuses subject to this test must be conditioned at 50°C. While being maintained at this temperature fuses undergo electrical tests to verify that they still operate as intended even at higher ambient temperatures.

### c. Current Cycling

Current Cycling tests the fuse reliability and longevity when subject to constant change in temperature and various current loads that would typically be experienced in photovoltaic applications. The life expectancy of typical photovoltaic installations can be in the range of 15-25 years. The current cycling test is intended to simulate this system life expectancy and its affect on the fuse. The goal is to prevent fuse nuisance openings due to normal system operating conditions. Fuse samples are first subject to the temperature cycling test as described in the section above. They are then conditioned in a humidity chamber for 5 days. Finally they are subjected to 3000 repetitions of current cycling. One current cycle consists of loading the fuse to 40%, 75% and 100% of its nameplate ampere rating for a specified amount of time, never falling below 15% during the duration of the test. Fuses must not open or show any physical signs of degradation (cracking, discoloration, etc.) and fuse resistance measurements must not differ by more than 10% of pre-test condition in order to pass this test.



One Current Cycle as defined by UL standard 2579

## 4. Summary

UL standard 2579, “Fuses for Photovoltaic Systems”, is a product standard written specifically for fuses intended to be used for photovoltaic circuit protection. Unlike UL standard 248, “Low Voltage Fuses”, fuses listed to UL standard 2579 are subject to additional testing, simulating the service environment conditions of photovoltaic installations. Although fuses listed to UL standard 248 may perform as needed they are not necessarily the optimal solution for photovoltaic applications. Fuses listed to UL standard 2579 will deliver overall improved system performance and longevity, adding to the overall value of your solar power installation.

## HelioProtection® by Mersen

HelioProtection by Mersen delivers engineered solutions specifically for photovoltaic applications including a full-line of UL 2579 listed fuses. Fuse solutions range from 600VDC to 1000VDC intended for photovoltaic string and array circuit protection. HelioProtection fuses comply with the UL standard 2579, CSA, European IEC standard 60269-6 and National Electric Code requirements. For more information regarding Mersen's HP6M, HP10M and HP6J series of HelioProtection fuses visit: [us-ferrazshawmut.mersen.com/helioprotection](http://us-ferrazshawmut.mersen.com/helioprotection).



**HP6M**



**HP10M**

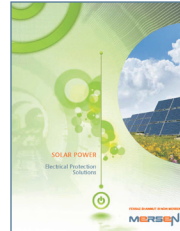


**HP6J**

## Additional Solar Power Solutions

Mersen offers comprehensive electrical protection solutions for solar power applications. Visit our website at [us-ferrazshawmut.mersen.com/solarpower](http://us-ferrazshawmut.mersen.com/solarpower) to explore additional product solutions and download our Solar Power Solutions Guide:

## Solar Power Solutions Guide



## Tech Topics:

- PVPN1: Ground-Fault Analysis and Protection in PV Arrays
- PVPN2: Line-Line Fault Analysis and Protection in PV Arrays

## Articles:

- Standards Critical in Solar Energy Power Protection, Solar Novus Today
- PV Installations, Protection and the Code (Canada), Electrical Business
- New Standards in Solar Power Circuit Protection, AltEnergyMag

## eLearning at [us-ferrazshawmut.mersen.com/PIQFS](http://us-ferrazshawmut.mersen.com/PIQFS)

- PIQ: Solar power circuit protection
- PIQ: News standards in solar power circuit protection