

# Arc-Fault Circuit Interrupter

Electric Arc Detection in PV Inverters

**Sunny Boy**



## Content

---

The *National Electric Code*® 2011 sets new requirements for PV plants that are installed on buildings. These requirements apply to newly installed PV plants that reach a DC voltage of more than 80 V.

Such PV plants must be equipped with an automatic electric arc detector and circuit interrupter.

The automatic electric arc detector provides supplementary protection against fires which may arise as a result of electric arcing.

SMA America LLC integrates this function into all Sunny Boy US inverters by means of an Arc Fault Circuit Interrupter (AFCI). This way, the cost and effort involved in equipping PV plants with an external AFCI is dispensed with.

What an electric arc is, how it occurs and what requirements apply to an AFCI is described in this technical information.

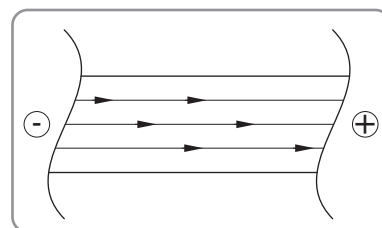
# 1 Why Do Electric Arcs Occur?

If a conductor is interrupted while direct current is flowing, a spark is created that ionizes the surrounding air. This creates plasma. If the direct current is sufficiently high, enough plasma is created to keep the direct current flowing. The direct current is now conducted via the plasma and is visible as an electric arc.

## How are Electric Arcs Formed?

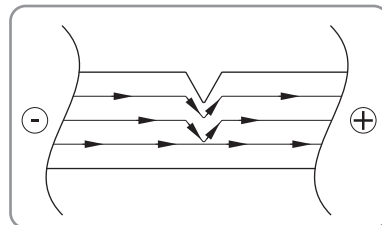
1. Intact conductor:

- The flow of direct current is uninhibited.



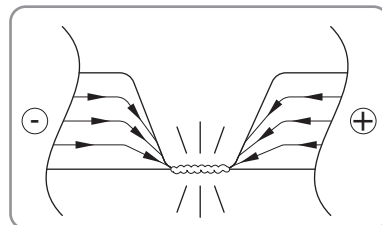
2. Damaged conductor:

- The current density is increased.
- The temperature of the conductor rises.
- The conductor melts.



3. Interrupted conductor:

- The conductor is destroyed by heat.
- Plasma is created due to ionization.
- The current flows in the form of an electric arc.



In rare cases, especially when there is strong DC current and the electric arc only has to bridge a short air distance, the interrupted conductor may be welded back together by the electric arc, thus allowing the direct current to flow again.

However, if the electric arc has to bridge a greater air distance, it can usually not be reignited once extinguished. Such electric arcs result in permanent interruption of the conductor.

## What are the Causes of Electric Arcs?

- Mechanical damage of the conductor, e.g., as a result of rodent bite.
- Increase in resistance of the contacts, e.g., by aging and corrosion of soldered and welded joints, or as a result of screw connections which have worked loose.

## 2 Standard Requirements

---

### **Serial Electric Arcs as Defined in the *National Electric Code*®**

"Arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the direct current PV source and output circuits."

*National Electrical Code*® 2011, Article 690.11

### **Current Requirements**

Issue 2011 of the *National Electric Code*® requires that all PV plants with a DC voltage of more than 80 V and installed on a building are fitted with a listed means of detecting and interrupting serial electric arcs on the PV side (PV AFCI) (Article 690.11: "Arc-Fault Circuit Protection (Direct Current)").

This requirement comes into force in the local context once the relevant requirement of the *National Electric Code*® has been adopted into the locally applicable regulations and as soon as the appropriate technology is available and has been tested and registered by independent laboratories.

The standard valid for the certification and registration of the PV AFCI is Subject 1699B Outline of Investigation, a supplement to UL 1699. This standard stipulates that an AFCI must detect an electric arc of 300 W power or more, and interrupt it within a time period of max. 2 s.

The AFCI must detect the electric arc and interrupt it. A tripped AFCI may only be reset manually. This means that automatic re-commissioning is not permitted.

## 3 Effects on Products and Operators

---

Providing that an appropriate, UL 1699 certified technology is available, newly installed PV plants must be equipped with an AFCI. For this purpose, the requirements of Article 690.11 of the *National Electrical Code*® 2011 must be adopted in the locally applicable electrical regulations.

### **Integrated SMA Solution**

Third party solutions for AFCI exist, however SMA America LLC offers most of its inverters with a pre-installed, UL listed AFCI functionality. Additionally, the system owner will be alerted of the fault via the inverter's communication link to expedite mitigation of this hazard.