DC Arc Flash

Purpose & Description

The purpose of this exercise is to study DC Arc Flash for photovoltaic (PV) systems. The methods considered include the maximum power method, stokes and Paukert.

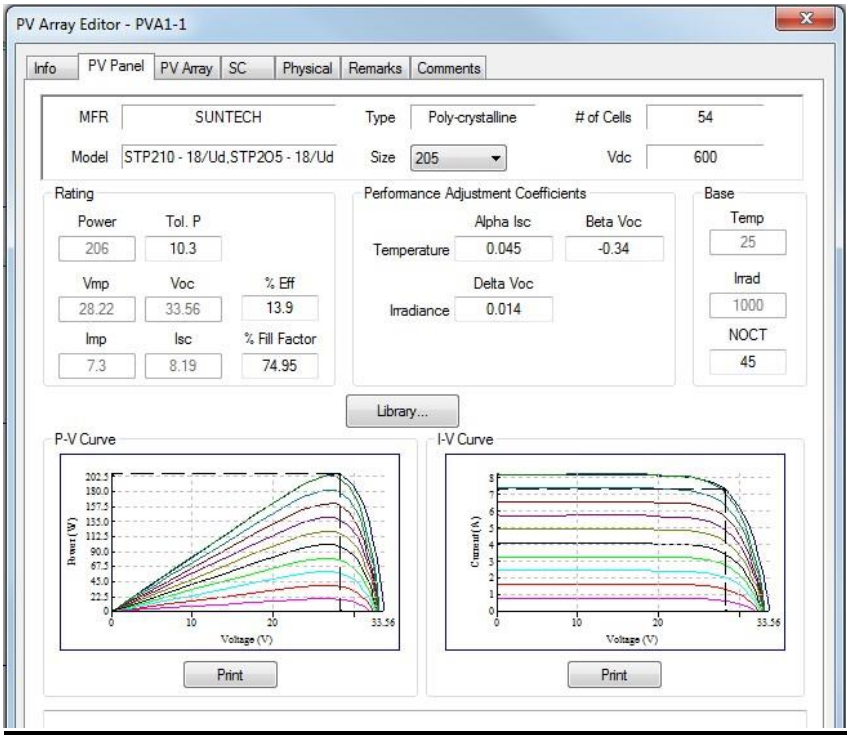
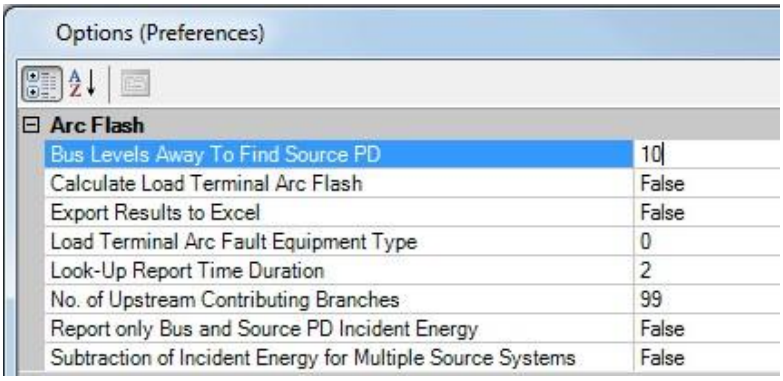


Figure 1 PV Array Editor with P-V and I-V Curves

Setup

Load the project file named "AF-Example10". Please make sure to have the following Options (Preferences) selected prior to beginning this exercise:



Load Library File: C:\ETAP 1200\Lib\etap1200.lib (or default library for newer versions of ETAP)

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Procedure

Step1
Select study case **MaxPower**. Run the DC arc flash calculation and name the report "**MaxPower**".

Step2
Select study case **Paukert**. Run the DC arc flash calculation and name the report "**Paukert**".

Step3
Select study case **Stokes**. Run the DC arc flash calculation and name the report "**Stokes**".

Using the DC arc flash result analyzer (DC AFRA), fill out the values in table 1 below for a fault at "DC
Colect-1"

Table 1: DC Arc Flash Analysis Results for fault at "DC Colect-1" DC Collector Panel

Scenario	Incident Energy (cal/cm^2)	Total Ia (kA)	Arc Resistance (Ohm)
MaxPower	2.63	0.367	0.34
Paukert	1.45	0.538	0.12
Stokes	1.57	0.51	0.15

Step 4
Configure the DC AFRA to determine which set of results yields the worst-case incident energy.

4.1 What method seems to yield the highest incident energy?

The worst-case incident energy seems to occur when running the maximum power method.

4.2 What is the gap between conductors (electrodes) used to determine the arcing current for steps 2 and 3?

The gap between the electrodes is 30 mm for steps 2 and 3. That is the Paukert and Stokes method are using the same gap.

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Step 5
Open the DC AF Parameters page of the DC Panel bus. Locate the Gap Between conductors field.

5.1 Change the Gap to 150 mm. Re-run the DC Arc Flash calculation using the Stokes Method. What is the new incident energy? Does the energy increase or decrease and explain?

The value of the incident energy is 0.94 cal/cm^2. The energy decreases. For a fixed clearing time the higher gap, distance causes less power to be delivered to the arc (i.e. the arc power changes).

5.2 Change the Gap to 200 mm. Re-run the DC Arc Flash calculation using the Stokes Method. Why is the message "TCC not found" returned by the program?

The arc gap is too long. Most likely, there may not be an arc generated or sustained.

5.3 Switch back to the MaxPower method study case and re-run the DC AF calculation. Why is the value of the incident energy still the same?

The maximum power method does not utilize the gap between electrodes. This major simplification sometimes may not yield the most conservative results.

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Description

This exercise compares the 3 methods ETAP uses to calculate DC Arc Flash Incident Energy to a paper called "Arc Flash Calculation for Exposures to DC Systems" Daniel R Doan IEEE Transactions on Industry Applications Vol. 46 NO. 6 November / December 2010. This paper illustrates common systems and hand calculates arcing current and incident energy.

Purpose

To compare different arc flash methods based on NFPA 70E 2012 standard.

Setup

- Load the project file named “Arc Flash Example 11”.
- Use the library file “AF-Example11.lib” located inside the example directory.

Procedure

Step 1

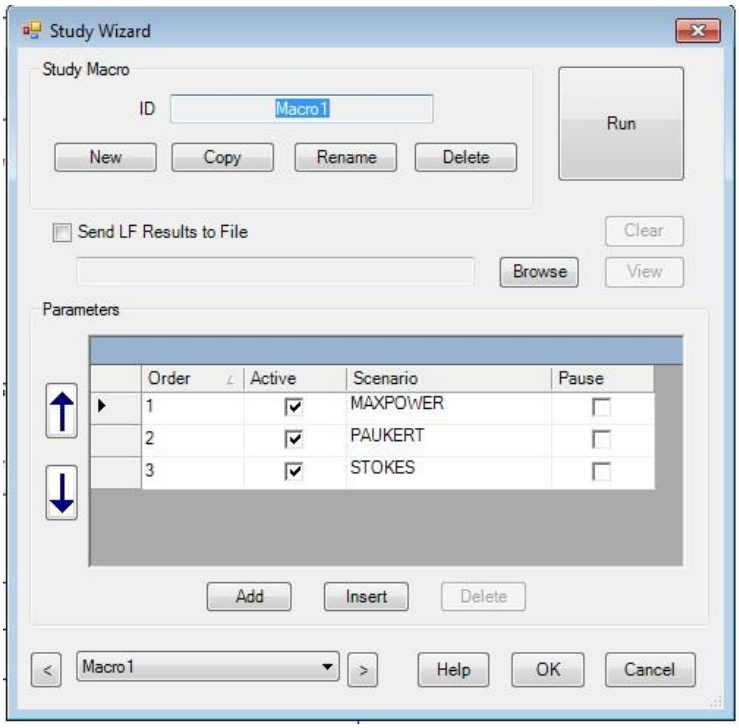
Setup the following scenarios using the “Scenario Wizard” tool.

Scenario ID	Study Type	Study Case	Report Name
MAXPOWER	DC Arc-Flash	MaxPower	MaxPower
PAUKERT	DC Arc-Flash	Paukert	Paukert
STOKES	DC Arc-Flash	Stokes	Stokes

Step 2

Setup a Macro that includes all three scenarios and Run the Macro

DC Arc Flash



Step 3

Open the DC Arc Flash Analyzer and fill in the incident energy value for each study method.

Faulted Bus	MaxPower	Paukert	Stokes
Electrochemical DC Bus	7.57	7.16	7
Substation Battery Bank	0.833031	0.820264	0.820725
UPS Batt System Bus	1.68	1.36	1.21

3.1 What method yields the highest incident energy results?

The worst case incident energy for all three faulted buses is the Maximum Power Method.

3.2 What is the reason why the answer to 3.1 gives the highest incident energy?

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When calculating the arcing current for the three methods, the Maximum Power Method divides the bolted current in half. It does not take into consideration if the arc can be sustained in certain conditions.

Step3

4.1 What is the average value of the current passing through UAT between 0.2 and 2.0 sec after the application of the Negative Field?

~9.141 (kA)

Step 5
Go back to Base revision. In short-circuit mode. Select configuration "Utility-Out". Enter the value of the Gen Ibf % FLA into the study case named "Decay-NEGF" which will make the Ibf contribution be approximately equal to the value from Step 4.1. Name the output report "NegF-Decay"

The value of Gen Ibf should be 67% FLA

5.1 Enter the incident energy value for this case into the table of Step 1.1.

The value should be ~20.82 cal/cm^2

5.2 What is the percent reduction in the incident energy when compared to the half cycle method?

The percent reduction for the incident energy is 53.7% or almost 54%.