Faculteit Technologie, Innovatie & Samenleving
ENERGY IN TRANSITION

Arc Detection Algorithm

A detection algorithm for arc faults in solar applications (DC-Girds)

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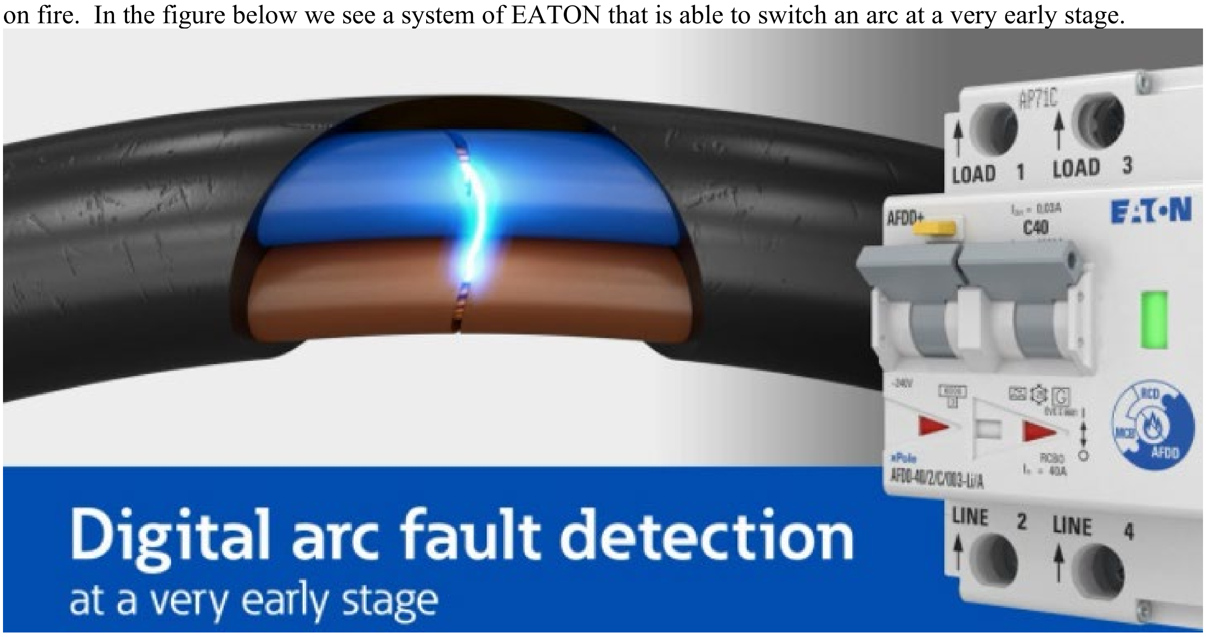
Duration:	*Shift 3 (10 weeks)*	
Start date:	*08-02-2021*	
Location:	*The Hague University of Applied Sciences – Delft DC-LAB*	
Theme:	*Direct Current Research*	

Introduction

The energy transition is a theme where a lot of research topics come together. This transition will take place over many years and will have a major impact on how electricity will be transported to consumers. Within the research group“Energy in Transition”of THUAS, the use of direct voltage instead of alternating voltage is an important topic. Since electricity transport with a DC voltage offers many advantages over AC voltage.

A major advantage of DC voltage is the ability to control the power flow in the grid. To be able to control currents, switching must take place in the DC network. This also raised the question of whether and to what extent this switching causes problems with regard to voltage and current peaks in the grid. Every (hard)switch will create a small arc, but also a broken cable will make an arc in the cable. Next to the problems we can have inside a cable, bad connections in PV systems are a big topic where arcing will cause roofs to catch fire.

In all of these situations we would like to detect a arc fault before the fault is strong enough to set a installation on fire. In the figure below we see a system of EATON that is able to switch an arc at a very early stage.



[https://www.youtube.com/watch?v=UtOmau4ym1Q]

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Assignment

In order to understand what arc detection is it is first necessary to determine a definition for arcing. Arcing is defined as a momentary partial discharge due to the intense concentration of an electric field (high voltage) across a dielectric. Many times an arcing condition can be seen as a luminous discharge caused by the ionization of air molecules, called corona. High impedance arcing is a temporary condition and it is not necessarily considered to be a sign of dielectric breakdown. Dielectric breakdown causes a massive amount of leakage current to flow through a product's insulation, while arcing usually produces momentary spikes in the nominal leakage current waveform. Arc detection circuitry was implemented to differentiate between these two conditions. There are also differences between a series arc and a parallel arc situation. Its your job to classify these kind of arc situations, in this way your algorithm can detect a real arc and even a near miss if your algorithm is not able to find a match. In these critical detection situations its better to give a warning then ignore an "almost" arc. Below are a few steps/requirements for this assignment.

<u>Assignment steps:</u>
1)Classifying a spark
2)Measure on a microcontroller
1) Find literature of the different numerical arc detection methods
2) Selection of a number of methods that are practically programmable
3) Programming detection method in C or Python (in a low level structured programming)
4) Create a spark with the spark gap for point to point connection and for point to plate connection
5) Measure various arcs for different currents and distances and sample this data using a high-end oscilloscope
6) Try out arc detection programs on the various arcs
7) Result, if the presence of an arc can be distinguished from a current with many harmonics as a result of the switching frequency of power electronics
8) (**optional**) Implementation on a microcontroller. Sampling of current, detection algorithm and indication of a arc fault using a LED signal (turn on LED).

<u>General idea of the classifying:</u>
1)Use the DC lab's spark setup
2)Measure current across a shunt with the best scope available
3)Detect the noise with the Fourier transform and hopefully the spark
4)Then create several types of arc's
5)Then compare the frequentie spectrum of the different arc situations.

<u>Literature IEEE Xplore:</u>
THUAS Library
Database
IeeeXplore

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Deliverables

The following products must be delivered during the assignment:

- A plan of approach with an analysis of what is needed to achieve the desired result within the first two weeks.
- Simulation models (if needed) (using CASPOC Simulations). (http://www.caspoc.com/support/download/)
- Final report in Paper format (not more than 6 pages), include additional Appendix I, II, III (this can be Simulations/PCB-Designs/Measurements/Code/etc. depending on your topic) and all in one LaTaX file.
- Progress report from all students in a weekly progress format, all in one LaTaX file.
- All LaTaX files should be shared through https://www.overleaf.com/ with your mentors.
- All documents / designs / simulations are shared online trough Microsoft Teams. All organized within folders and sub-folders, all files should have a good name, version numbers and date stamps.
- Design a project poster on A1 format, this poster should be able to sell your product or inform students.
- Create educational content (recordings) that will be uploaded on YouTube, a total of 5 clips (topics).
- Use your algorithm during a final demonstration and Power Point presentation in the assessment-week.