

# sktp-10-03-2022 07\_31\_01- 210400

*by Izza Anshory, St., Mt., Dr.*

---

**Submission date:** 13-Jan-2023 01:35PM (UTC+0700)

**Submission ID:** 1992171216

**File name:** sktp-10-03-2022\_07\_31\_01-210400\_1.pdf (915.36K)

**Word count:** 3084

**Character count:** 14528

PAPER · OPEN ACCESS

## Analysis of Overcurrent Safety in Miniature Circuit Breaker AC (*Alternating Current*) and DC (*Direct Current*) in Solar Power Generation Systems

To cite this article: Jamaaluddin Jamaaluddin *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **819** 012029

View the [article online](#) for updates and enhancements.

### You may also like

- 1 - A novel beamformer-based imaging of phase-amplitude coupling (BIPAC) unveiling the inter-regional connectivity of emotional prosody processing in women with primary dysmenorrhea  
Hui-Ling Chan, Intan Low, Li-Fen Chen et al.
- 4 - THE DARK ENERGY CAMERA  
Flaugher, H. T., Diehl, K. Honscheid et al.
- Effective Reduction in Crosstalk Effects in Quaternary Integrated Circuits Using Mixed Carbon Nanotube Bundle Interconnects  
Mohammad Hossein Moayeri, Zahra Hajmohammadi, Maryam Rezaei Khezeli et al.



**ECS** The Electrochemical Society  
Advancing solid state & electrochemical science & technology

242nd ECS Meeting  
Oct 9 – 13, 2022 • Atlanta, GA, US

Abstract submission deadline: **April 8, 2022**

Connect. Engage. Champion. Empower. Accelerate.

**MOVE SCIENCE FORWARD**

Submit your abstract

This banner features a teal background with white text. On the right side, there are two images: the top one shows a group of people in a professional setting, and the bottom one shows a city skyline with a lake in the foreground.

## Analysis of Overcurrent Safety in Miniature Circuit Breaker AC (Alternating Current) and DC (Direct Current) in Solar Power Generation Systems

Jamaaluddin Jamaaluddin<sup>1\*</sup>, Indah Sulistiyowati<sup>2</sup>, Reynanda BWA.<sup>3</sup>, Izza Anshory<sup>4</sup>

<sup>1,2,4</sup>Universitas Muhammadiyah Sidoarjo, Indonesia

<sup>3</sup>Universitas Muhammadiyah Surabaya, Indonesia

\*jamaaluddin@umsida.ac.id

**Abstract.** The sun is a source of energy and has advantages over fossil energy sources. This solar energy really needs to be researched and developed further. The use of solar energy is by installing a *Photovoltaic Cell (PV)* along with the Solar and Battery Control system. In short, it can be referred to as a *Solar Power Plant (PLTS)*. This *PLTS* will be used in buildings as the *Solar Building System (SBS)*. Completing this system requires a protection system management. The protection system known to the general public is the use of a *Miniature Circuit Breaker (MCB)*. This *MCB* is intended for direct current and alternating current. To get a good protection system in PV mini-grid, how to use *MCB* and how to install it must be chosen. So that you will get a conclusion that the characteristics and level of efficiency are better than the two uses of the *MCB*.

**Keywords:** *Solar Building System (SBS); Magnetic Circuit Breaker (MCB); Solar Power Plant.*

### 1. Introduction

In this modern era, the human need for electrical energy is one of the main needs and this need for electrical energy is one indicator of a country's progress. To fulfill this, the generation of electrical energy is needed. Where at <sup>6</sup> is time humans still use fossils to meet their energy needs. So that the longer it is getting depleted, the average growth in energy demand is estimated at 4.7% per year during 2011 - 2030 [1].

The *Solar Power Plant (PLTS)* is one of the developments in the use of renewable energy which has the potential to be applied in Indonesia which has the potential for solar radiation an average of 4.8kWh / m<sup>2</sup> / day [1]. Besides producing electrical energy from the conversion of solar light energy, solar cells have other advantages, namely high reliability, not polluting the environment (causing no emissions), and not causing noise, although in terms of development efficiency and operation, further research is needed. also at the University of Muhammadiyah Sidoarjo so that this *PLTS* can be used as an alternative energy source, in addition to the utilization of *PLN electricity* [2].

The performance of a *photovoltaic cell (PV)* depends on the sunlight it receives. Climatic conditions (eg clouds and fog) also have a significant effect on the amount of solar energy received by cells so that it will also affect their performance as proven [3] [4].



<sup>3</sup> Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

In this research, the *PLTS* will be used as an alternative energy source in the Electrical Engineering Laboratory. To complete this system, it is necessary to have adequate and reliable protection management. The protection meant here is the use of a *Miniatur Circuit Breaker (MCB)*. There are several very basic treatments in this *MCB*, especially in the use of the *PLTS* system, namely:

The characteristics of using *MCB DC* or *AC* are the most reliable for *PLTS* systems.

1. What is the most reliable *MCB* installation in the *PV* mini-grid system. System input output

2. In which part should the *MCB* be installed in the *PV* mini-grid system.

This is done as a research tool for the initial steps of implementing the *Solar Building System (SBS)* as well as a means of reducing the cost of electrical energy supplied by *PLN* [5] [6].

## 2. Method

### 2.1. Research Flowchart

The research flow chart in this method is as shown in Figure 1.

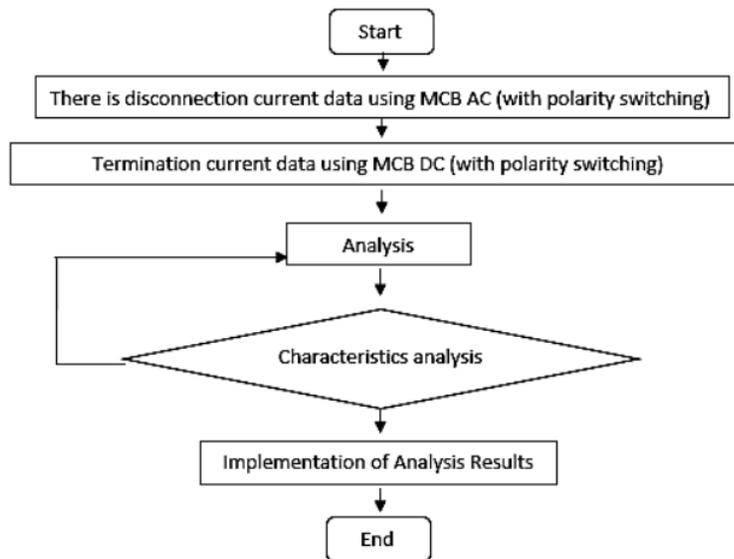


Fig. 1. Research flow chart

The research to be carried out has the following stages:

### 2.2. Research Stages

This research was carried out with the following activity plans, including:

1. Installation of *PV* at the Electrical Engineering Laboratory campus 2 Muhammadiyah University Sidoarjo. Along with a current storage device (accumulator), control unit filling and load. Simulated the use of *PV* power interconnected with the *Sub Distribution Panel (SDP)* in the Electrical Engineering Laboratory. The collection of disconnection current data using *MCB AC* and *DC* by changing the polarity of the output voltage.
2. Data analysis of the characteristics of the *MCB AC* and *MCB DC*.
3. Perform system applications and try their application on the system installed in the Electrical Power and Energy Conversion Engineering Laboratory, University of Muhammadiyah Sidoarjo.
4. Evaluation and improvement.

5. Reporting.

2.3. Data collection technique

Data collection techniques used by researchers to support research are: Measurement of *MCB AC* and *DC* disconnection currents with polarity exchange using an *DC* system. This measurement is carried out using a *DC* generator and measured using an ampere meter.

This measurement is carried out using a *DC* generator and measured using an ampere meter.

3. Results

3.1. Block Circuit Diagram

The PV mini-grid block diagram is shown in Figure 2. Figure 2. shows the *PLTS* system starting from *Photovoltaic (PV) - Solar Charge Controller (SCC)* - divided by two, the first to the load and the other to the *ACCU*.

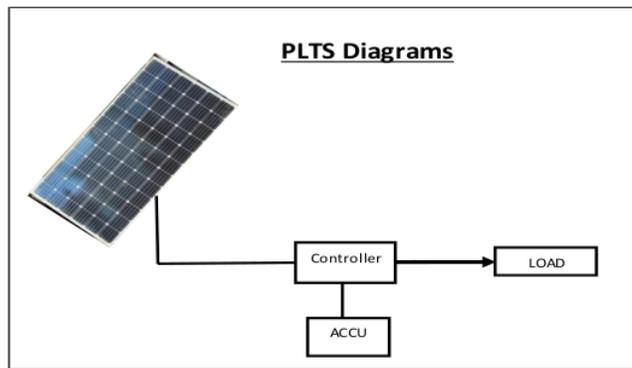


Figure 2. *PLTS* block diagram

The series used for the implementation of the research is as shown in Figure 3. Measurement of *MCB AC* and *DC* disconnection currents with polarity exchange using a *DC* system. This measurement is carried out using the output from the *SCC*, namely by using a *DC* current with an inverted *MCB* polarity. By measuring the current in its path using an ampere meter. The series can be seen in Figure 3.

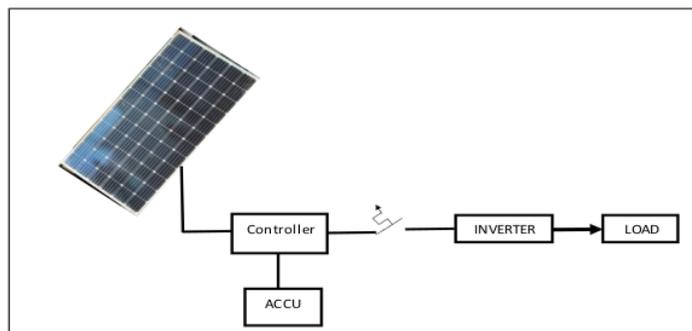


Figure 3. Block Diagram Of *MCB AC* And *DC* Testing Using *DC* Currents

The research process uses a schematic diagram as shown in Figure 3., the current measurement is carried out starting from the current 0 to the *MCB* disconnection current.

### 3.2. Components and Circuits Used

The components used are as shown in the documentation in Figures 4 to 5. .



Figure 4. Photovoltaic.

Figure 4. shows this *Photovoltaic (PV)* image is used to capture the Sun's energy to be converted into Electric Power.



Figure 5. Solar Charge Controlled (SCC)

Figure 5. shows a picture of the *Solar Charger Controller (SCC)* which is used to regulate the incoming current and voltage from the *PV* to the battery and load. Besides the two components above, there are other components that are used for testing, namely *MCB AC* and *MCB DC*. The *MCB AC* image is as shown in Figure 6 and the *MCB DC* image is as Figure 7.



Figure 6. *MCB AC* With Voltage And Current Meters

In Figure 6, namely *MCB AC* using the *ABB* brand with a capacity of C6, which is a disconnection current of 6 A.



Figure 7. *DC MCB* With Voltage And Current Meters

In figure 7, namely *MCB DC* using the *TOMZN* brand with a capacity of C3, namely the disconnecting current of 3 A. The photo of the test series as a whole can be seen in Figure 8. This image shows a test circuit using a *PV* system and an inverter.



Figure 8. Test circuit using *DC MCB* and *AC MCB* with Voltage and Current Meters

In Figure 8, you can see the full circuit of *DC* and *AC MCB* testing systems and setting the current through them using *DC* or *AC* currents. The *DC* current uses the output from the *SCC*, while the *AC* current test uses the output current from the inverter. For load testing using a series of lamps and other loads available.

### 3.3. Measurements Taken

Measurements taken to carry out this research are: *DC* Current Measurement on *AC MCB AC* and *DC MCB*. This measurement is carried out using a *DC* ampere meter at the point after the *SCC* to the load on the *PLTS* system by providing an initial load of 0 to the break of the *MCB*. Measurement was carried out with 2 different treatments, namely by reversing the polarity of the *DC* current source.

**3.4. Measurement results**

*DC* Current Measurement on *AC MCB* and *DC MCB* This measurement is carried out using a *DC* ampere meter at the point after the *SCC* to the load on the *PLTS* system by providing an initial load of 0 to the break of the *MCB*. Measurement was carried out with 2 different treatments, namely by reversing the polarity of the *DC* current source.

Table 1. Measurement of *AC-DC MCB* load Input Position Below and Output Above

NO	TRY INTO	BREAK CURRENT
<b>A MCB AC LOAD DC</b>		
<b>1 1st Treatmen (Input Position Lower Output Top)</b>		
1.1.	1 st Trial	4,740
1.2.	2 nd Trial	3,020
1.3.	3 rd Trial	2,700
1.4.	4 th Trial	2,670
1.5.	5 th Trial	2,820
<b>AVERAGE BREAK VALUE</b>		<b>3,190</b>

In table 1. You can see the measurement of the cut-out current on the *AC MCB* with a *DC* load. The input polarity is below the *MCB* and the output is above, with a *MCB* capacity of 6 A, so the results of the study show that the current termination at an average current is 3.190 A.

Table 2. Measurement of *AC-DC MCB* load Input Position Above and Output Below

NO	TRY INTO	BREAK CURRENT
<b>B MCB AC LOAD DC</b>		
<b>2 2 nd Treatmen (Input Position Upper Output Lower)</b>		
2.1.	1 st Trial	2,420
2.2.	2 nd Trial	3,850
2.3.	3 rd Trial	3,900
2.4.	4 th Trial	3,760
2.5.	5 th Trial	3,910
<b>AVERAGE BREAK VALUE</b>		<b>3,568</b>

In table 2. You can see the measurement of the cut-out current on the *AC MCB* with a *DC* load. The input polarity is above the *MCB* and the output is below, with a *MCB* capacity of 6 A, so the results of the study show that the current termination at an average current is 3.568 A. on if the input polarity is up.

for more details can be seen in the figure. 9. In Figure 9 it can be seen that the input position below and the output above has a more precise security result than the input position above and the output below.

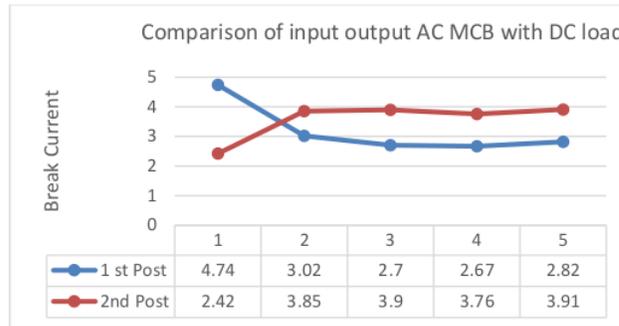


Figure. 9. Comparison of input output AC MCB with DC Load

Table 3. Measurement of DC load DC MCB Input Position Below And Output Above

NO	TRY INTO	BREAK CURRENT
<b>C</b>	<b>MCB DC LOAD DC</b>	
<b>3</b>	<b>1st Treatmen (Input Position Lower Output Top)</b>	
3.1.	1 <sup>st</sup> Trial	5,180
3.2.	2 <sup>nd</sup> Trial	5,190
3.3.	3 <sup>rd</sup> Trial	5,200
3.4	4 <sup>th</sup> Trial	5,220
3.5.	5 <sup>th</sup> Trial	5,210
	<b>AVERAGE BREAK VALUE</b>	<b>5,200</b>

In table 3. You can see the measurement of the cut-out current on the DC MCB with the DC load. The input polarity is below the MCB and the output is above, with a MCB capacity of 6 A, so the results of the study show that the current termination is at an average current of 5,200 A.

Table 4. Measuring DC load DC MCB Input Position Above and Output Below

NO	TRY INTO	BREAK CURRENT
<b>D</b>	<b>MCB DC LOAD DC</b>	
<b>4</b>	<b>2nd Treatmen (Input Position Upper Output Lower)</b>	
4.1.	1 <sup>st</sup> Trial	4,300
4.2.	2 <sup>nd</sup> Trial	4,310
4.3.	3 <sup>rd</sup> Trial	4,320
4.4.	4 <sup>th</sup> Trial	4,330
4.5.	5 <sup>th</sup> Trial	4,350
	<b>AVERAGE BREAK VALUE</b>	<b>4,322</b>

In table 4. You can see the measurement of the cut-out current on the DC MCB with the DC load. The polarity of the input is above the MCB and the output is below, with a capacity of 6 A MCB, the results show that the current termination at an average current of 4.322 A. on if the input polarity is down.

Meanwhile, to compare the same *MCB* capacity with different loads, the results are as shown in the graph in Figure 10.

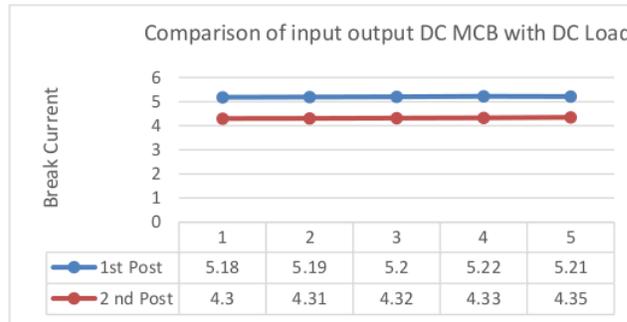


Figure. 10. Comparison of input output *DC MCB* with *DC Load*

In Figure 10 it can be seen that the input position below and the output above has a more precise security result than the input position above and the output below.

#### 4. Conclusions and Suggestions

##### 4.1. Conclusion

The value of the cut-out current when using an *AC MCB* with a *DC load* with a polarity ratio, it is found that: By using the input polarity on the bottom of the *AC MCB*, it has a more precise value than if the input is placed on the top of the *AC MCB*. The value of the cut-out current if you use an *AC MCB* with *AC load* and with a *DC load*, it is found that: The termination current value if using a *DC MCB* with a *DC load* with a polarity ratio, it is found that: By using the input polarity on the top of the *DC MCB*, it has a more precise value than if the input is placed on the bottom of the *DC MCB*.

##### 4.2. Suggestion.

In future research, it is better to involve the element of calculating the time when the *MCB* is in the cut-out current position.

#### Acknowledgements

A big thank you to DRPM Muhammadiyah University Sidoarjo who has helped the realization of this paper both morally and materially. Hopefully your acts of worship are accepted and get a lot of rewards from Allah SWT.

#### References

- [1] M. Bortolini, M. Gamberi, and A. Graziani, "Technical and economic design of photovoltaic and battery energy storage system," *Energy Convers. Manag.*, vol. 86, pp. 81–92, 2014.
- [2] Jamaaluddin, I. Robandi, I. Anshory, Mahfudz, and R. Rahim, "Application of interval type-2 fuzzy inference system and big bang big crunch algorithm in short term load forecasting new year holiday," *J. Adv. Res. Dyn. Control Syst.*, 2020.
- [3] Jamaaluddin, I. Robandi, and I. Anshory, "A very short-term load forecasting in time of peak loads using interval type-2 fuzzy inference system: A case study on java bali electrical system," *J. Eng. Sci. Technol.*, vol. 14, no. 1, pp. 464–478, 2019.
- [4] A. Supriyadi, J. Jamaaluddin, T. Elektro, and U. Muhammadiyah, "Analisa Efisiensi Penjejak Sinar Matahari Dengan Menggunakan," *Jee-U*, vol. 2, no. APRIL, 2018, pp. 8–15, 2018.
- [5] B. P. dan P. T. I. Penelitian, *Outlook Energi Indonesia 2013*. 2013.

- [6] M. Muchlis and A. D. Permana, "Proyeksi Kebutuhan Listrik PLN 2003 s.d. 2020," Pengemb. Sist. Kelistrikan dan Menunjang Pembang. Nas. Jangka Panjang, p. 11 Halaman, 2003.
- [7] California Energy Commission, "A guide to photovoltaic system design and installation," Calif. Energy Comm., no. June, p. 39, 2001.
- [8] B. García-Domingo, M. Torres-Ramírez, J. De La Casa, J. Aguilera, and F. J. Terrados, "Design of the back-up system in Patio 2.12 photovoltaic installation," Energy Build., vol. 83, pp. 130–139, 2014.
- [9] Sekretariat Perusahaan PT. PLN, "Statistik PLN 2014," no. 02701, p. iv, 2015.
- [10] Dickson Kho, "Pengertian MCB (Miniature Circuit Breaker) dan Prinsip kerjanya," Tek. Elektron., 2018.
- [11] H. Pradika and M. Moediyono, "THERMAL OVERLOAD RELAY SEBAGAI PENGAMAN OVERLOAD PADA MINIATUR GARDU INDUK BERBASIS PROGRAMMABLE LOGIC CONTROLLER (PLC) CP1E-E40DR-A," Gema Teknol., 2015.
- [12] A. Goeritno and S. Pratama, "Rancang-Bangun Prototipe Sistem Kontrol Berbasis Programmable Logic Controller untuk Pengoperasian Miniatur Penyortiran Material," J. Rekayasa Elektr., 2020.
- [13] S. Bartien, "Puil 2011," DirJen Ketenagalistrikan, 2011.
- [14] Kementerian Energi dan Sumber Daya Mineral, Statistik ketenagalistrikan 2015. 2014.

ORIGINALITY REPORT

---

4%

SIMILARITY INDEX

3%

INTERNET SOURCES

1%

PUBLICATIONS

2%

STUDENT PAPERS

---

PRIMARY SOURCES

---

1

[pubmed.ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov)

Internet Source

1%

---

2

Submitted to University of Liverpool

Student Paper

1%

---

3

[www.hrpub.org](http://www.hrpub.org)

Internet Source

1%

---

4

[bioelecnoise.scienceontheweb.net](http://bioelecnoise.scienceontheweb.net)

Internet Source

1%

---

5

Submitted to Druid Hills High School

Student Paper

1%

---

6

[id.scribd.com](https://id.scribd.com)

Internet Source

1%

---

Exclude quotes  On

Exclude matches  < 1%

Exclude bibliography  On