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Nomor: 568.8/II.3.AU/14.00/C/KET/III/2022

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Judul Artikel	:	Analysis of Overcurrent Safety in Miniature Circuit Breaker AC (Alternating Current) and DC (Direct Current) in Solar Power Generation Systems
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sktp-10-03-2022 07_31_01-210400

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Submission date: 11-Mar-2022 10:08AM (UTC+0700)
Submission ID: 1781597879
File name: sktp-10-03-2022_07_31_01-210400.pdf (915.36K)
Word count: 3084
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To cite this article: Jamaaluddin Jamaaluddin *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **819** 012029

IOP Conf. Series: Earth and Environmental Science **819** (2021) 012029 doi:10.1088/1755-1315/819/1/012029

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

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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 this 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 / m2 / 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].

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.

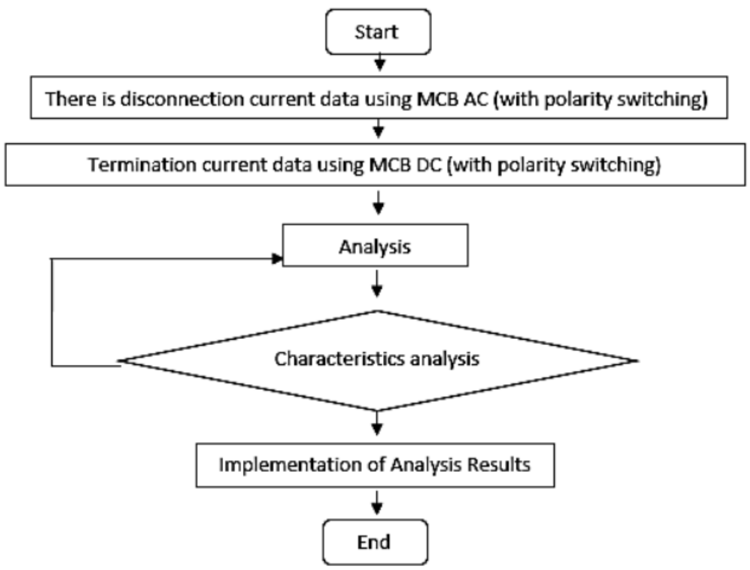

Fig. 1. Research flow chart

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.

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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.

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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*.

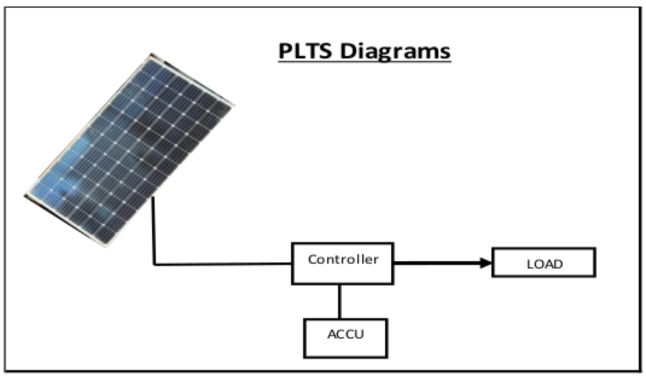

Figure 2. *PLTS* block diagram

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.

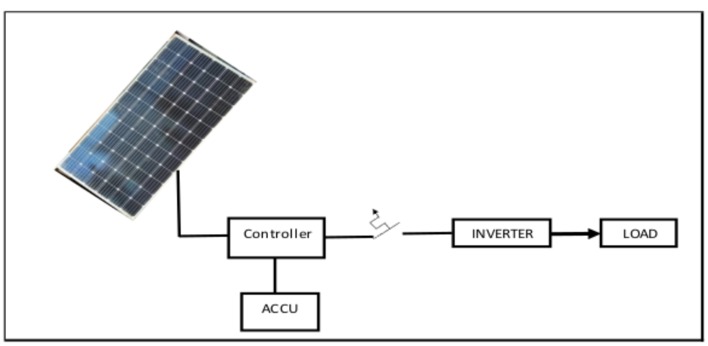

Figure 3. Block Diagram Of *MCB AC* And *DC* Testing Using *DC* Currents

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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.

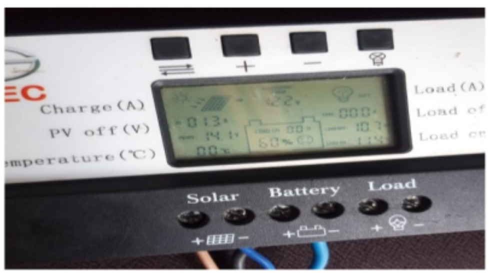

Figure 5. Solar Charge Controlled (SCC)

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*, which is used *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

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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.

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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
A	MCB AC LOAD DC		
1		1st Treatmen (Input Position Lower Output Top)	
	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
		AVERAGE BREAK VALUE	**3,190**

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	MCB AC LOAD DC		
2		2 nd Treatmen (Input Position Upper Output Lower)	
	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
		AVERAGE BREAK VALUE	**3,568**

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.

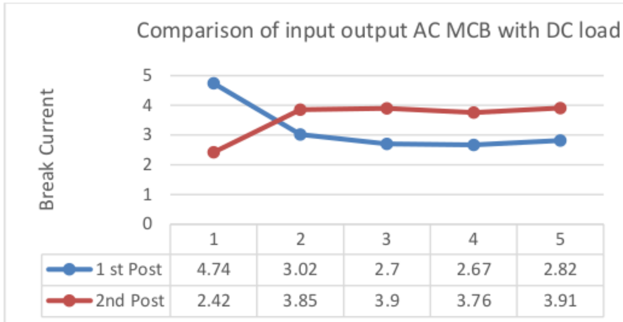

Figure. 9. Comparison of input output *AC MCB* with *DC* Load

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

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

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
D	MCB DC LOAD DC		
4		2 nd Treatmen (Input Position Upper Output Lower)	
	4.1.	1 st Trial	4,300
	4.2.	2 nd Trial	4,310
	4.3.	3 rd Trial	4,320
	4.4.	4 th Trial	4,330
	4.5.	5 th Trial	4,350
		AVERAGE BREAK VALUE	**4,322**

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.

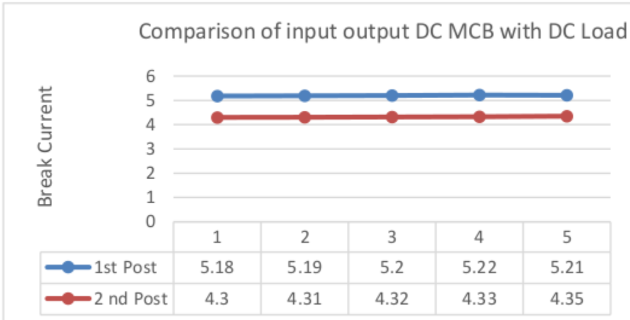

Figure. 10. Comparison of input output *DC MCB* with *DC* Load

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," Jeee-U, vol. 2, no. APRIL, 2018, pp. 8–15, 2018.
[5] B. P. dan P. T. I. Penelitian, Outlook Energi Indonesia 2013. 2013.

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[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.

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