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Fault Detection and Isolation of DC Micro-Grid

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***Abstract:** In a microgrid, faults can lead to voltage instability, which can produce voltage sags, swells, or even a full collapse of the voltage. This may result in electrical equipment damage and interfere with the microgrid's operation. Faults can also produce safety risks including fire, explosion, or electrocution, which can endanger employees and harm equipment. By isolating or shutting down the system when a malfunction is found, the danger of harm or injury is reduced. The purpose of fault isolation and detection in a DC microgrid is to guarantee the microgrid's dependability and safety. The microgrid's flaws are found using fault detection and isolation (FDI) techniques, which are then used to isolate them so they won't influence other system components. The microgrid's downtime can be reduced by immediately identifying and isolating issues, ensuring a steady supply of electricity to the associated loads. Additionally, fault isolation and detection can stop problems from spreading to other system components, which can reduce the severity of the fault's harm. The purpose of this research is to identify and isolate faults that occur in DC microgrids, as well as to minimise their impact. In this project fault detection and isolation is properly done, for detecting a fault microprocessor is used which continuously monitor the values of current and voltage and for isolation of microgrid relay is used. We are successfully providing the circuit which detects the fault and isolate within the time which reduces the severity of fault and protect the healthy*

***Keywords:** Dc Micro Grid, Faults, Detection and Isolation, Power Supply.*

1. INTRODUCTION

Every electrical installation uses a variety of equipment to ensure the proper operation of the circuits, but it is crucial to ensure that none of these equipment malfunctions can interrupt the continuous power supply. It is also crucial that any malfunctions should last no longer than necessary because doing so can lower the system's efficiency and reliability. There are various approaches that we applied in our project to correct these flaws as soon as feasible before they worsened into more serious circumstances. DC microgrids may experience a number of atypical circumstances that could lead to system instability or collapse. A

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generator failure or an excessive load demand can both cause undervoltage. It may result in a system blackout, equipment failure, and a decline in system stability. Short circuits and equipment overload can both result in overcurrent. When a portion of the microgrid experiences islanding, it keeps running even after a blackout affects the entire system. Both safety risks and equipment damage could result from this. Different protection and control strategies, such as overcurrent protection, voltage regulation, fault detection, and islanding detection techniques, can be used to prevent and reduce these abnormal conditions. These types of problems can be identified in this presentation and can be isolated from the circuit. Relay is employed in this architecture to isolate failures, and a PIC microcontroller is used for monitoring. The main goal of this presentation is to identify faults and correctly isolate the faulty section in order to prevent further damage to the circuit. Continuous sensors measure the current and voltage; if these values rise above threshold levels, a fault is indicated and a relay enters the picture to isolate the problematic area. A more contemporary idea known as microgrid, which is a systematic organisation of distributed generating systems, was made possible by the advent of distributed generation. Microgrid has additional capacity and control flexibility to meet system dependability and power quality needs compared to a single distributed generating. The microgrid has two modes of operation. They come in grid-connected and freestanding modes. You can separate the microgrid into AC bus and DC bus systems. Lack of a current zero crossing causes protection issues for the dc distribution system. However, the ac transmission and distribution system has undergone significant progress protection technology is straightforward and simple to use. While most microgrids use an AC system as their primary means of distribution, researchers are looking into DC microgrids in order to better connect with DC output sources including photovoltaic (PV), fuel cells, and secondary batteries. Table 1 shows the literature review in that many fault detection and isolation techniques are introduced. after that method which are used in this project is discussed. This project is practically used for applying power to any home or particular area. The below figure shows practical application of this project.

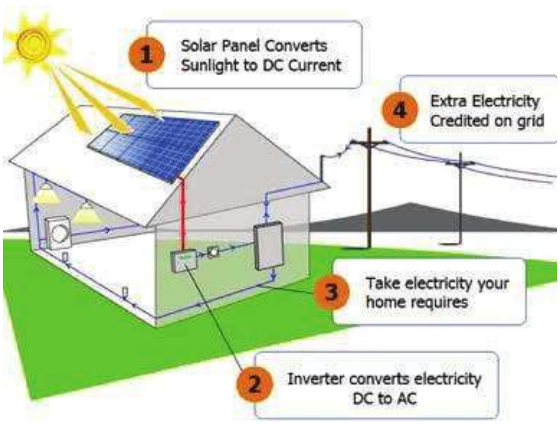

Fig 1: generation electricity from solar energy

Literature Review

A novel technique for fault detection and diagnosis in photovoltaic (PV) arrays is presented in the work titled "A circuit analysis-based fault-finding algorithm for photovoltaic array under

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LL/LG faults". The authors create a thorough model for a PV array's circuit analysis that takes into consideration both single and double line-to-ground (LL/LG) faults. They then create a fault-finding algorithm that can locate and classify errors in the array using this approach. But the paper might still be enhanced in a few places. First of all, more information on the experimental setup used to validate the method, including the kinds of PV modules and inverters utilised, the measurement tools, and the test settings, might have been provided by the authors. Second, the authors may have talked about the algorithm's drawbacks, such as its sensitivity to measurement errors, the effects of partial shading on fault identification, and the performance implications of other fault kinds (such as open circuit and short circuit). The study "Fault Detection and Isolation in DC Microgrids Using a Hybrid Bayesian Approach" suggests a fresh approach for finding and isolating faults in DC microgrids. The work is well-organized and provides a succinct explanation of the suggested strategy as well as the actual experimental data The proposed method was compared to two other methods, a model-based approach and a data-driven approach, and the authors demonstrated that the hybrid Bayesian approach outperformed both of them in terms of accuracy and speed. The experimental results presented in the paper demonstrate the effectiveness of the
proposed method in detecting and isolating faults in DC microgrids. The detailed literature survey is shown in below table:

Sr No.	Paper Topic	Findings
1.	A circuit analysis-based fault-finding algorithm for photovoltaic array under LL/LG faults.	The proposed algorithm uses the voltage and current data obtained from the PV array to detect and locate faults.
2.	DC Microgrid Technology	This paper presents different aspects of DC microgrid such as interface with AC grid, power quality, architecture, grounding, applications, and standardization.
3.	An overview of DC-DC converter topologies and controls in DC microgrid	This Paper discusses the present status of control strategies, DC-DC Converters topologies and protection in DC Microgrid Among these, Buck and boost have better performance over buck-boost and Cúk converters.
4.	Model-Based Fault Detection and Isolation in DC Microgrid	To use a model-based approach to fault detection and isolation, which involves creating a mathematical model of the microgrid and analyzing the behavior of the system under different fault conditions.

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5.	voltage based protection for micro-grids containing power electronic converters.	The voltage-based protection system is designed to monitor the voltage levels in the micro-grid and detect any abnormal voltage conditions that may result from faults such as short circuits, overloads, or voltage sags.
6.	Fault Detection and Isolation in DC Microgrids Using a Hybrid Bayesian Approach.	Use of different models for different fault scenarios or the combination of multiple models to improve overall fault detection and isolation performance
7.	A Model-Based Approach for Fault Detection and Isolation in DC Microgrids	propose a model-based approach for fault detection and isolation in DC microgrids.

Table 1: Literature Survey

2. METHODOLOGY

The methodology used for the fault detection isolation is very simple and effective. For detecting a faults microcontroller is used and for isolation purpose relay is used. The solar panel of rating 21w is used as a renewable resource which generate the dc power by absorbing the sun rays. The is used for the storage purpose. In this project we are mostly focusing on the faults detection and isolation, the faults line undervoltage, line to line fault and line to ground fault are detecting and isolating from the healthy system. If any two lines of positive or negative lines are shorted or touch to each other the line-to-line fault will occur, if any positive or negative line is touch to ground of the system or any ground line of the equipment the line to ground fault will occur. the next condition for the undervoltage if when the voltage of solar panel is under 6v or below 6v then undervoltage will occur. This all information is continuously observed by the microcontroller and when this are not in the range the it indicates the fault. after any fault occur in the system microprocessor will generate the signal and send to the relay to trip and isolate the faulty part from the further part. Below block diagram shows the flow of power in the system.

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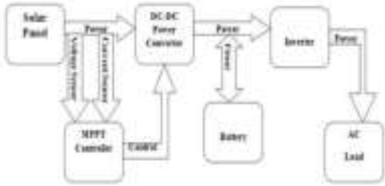

Fig 2: Block Diagram

In this project dc-dc converters are used. the boost converter is coming in operation when the voltage from the solar panel is getting below 12v. If the voltage from the panel is getting only 10v then the boost converter converts the 10v into 24v and send send to the buck converter. Whatever the voltage from panel boost convert maintains the voltage of 24v only. The output of boost converter is given to the buck converter to step down it up to 12v it only for the charging purpose of battery. In this project the only restriction is that we can only used 12v dc load because handling a large amount of voltage under fault condition very risky. But we can use load up to 24v by connecting two led lamps in series.
The circuit diagram shows the conclusion of above explanation.

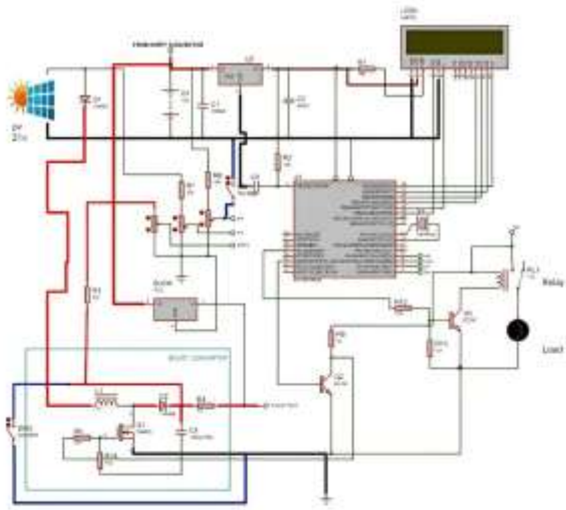

Fig 3: circuit diagram of proposed methodology

The method used here are:
a. -Initialize all ports and peripherals [ADC, Timers, Compare Modules]
b. -Initialize interrupts for Timer0 and compare module for
c. - check SOLAR PANEL voltage level
d. -If SOLAR PANEL voltage level < 11.5v load connected to converter trips.
e. -Check output voltage, adjust as required
f. This is a quasi-sine wave inverter that we made since it was more demanding than the sine at the time. we have a project with quasi-sine wave as well with a PIC microcontroller.

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g. The design here uses IRFP150 x 1 on each leg for 6Amp. We can use other MOSFETs as well. There are 1 transistor for driving the MOSFETs, on the control board - bc547.
h. For microcontroller, a constant 5v is required which draws from 12 v by using 7805 regulators.

Algorithm used for the dc-dc converter:
By identifying an open circuit defect, the open circuit algorithm is a control method used in DC-DC converters to safeguard the converter from overvoltage situations. An open circuit fault occurs when one of the circuit's components—such as an inductor, a capacitor, or a switch—fails or disconnects, causing an abrupt rise in the converter's output voltage. The converter's output voltage is monitored and compared to a preset threshold value to operate the open circuit procedure. The algorithm activates a protection mechanism that turns off the switch (or switches) in the converter to disable it when the output voltage exceeds the threshold value. This stops the output voltage from rising further and safeguards the load and other circuit components from harm. The open circuit algorithm normally waits a while after the protective mechanism is activated before attempting to restart the converter. The converter's output capacitance stores energy that gradually dissipates during this waiting period, allowing the output voltage to stabilize at a safe level. The algorithm tries to restart the converter when the waiting period is ended by gradually increasing the duty cycle of the converter's switch(es).

3. RESULT

In circuit diagram shown in the figure 2 we not showing the part of inverter but it is there, in this project invert part and AC part will add in this project. we are getting the approximate values of input and output voltages from panel, converters and from battery.

Here are some results we get from the model:
1. Solar Panel output voltage: appr 21v
2. Boost converter output voltage: approximate 24v
3. Battery voltage: 12v
4. Output voltage :12v

After getting ON inverter
The output at PWM ic is shown in figure 4
a.) 50% duty cycle square wave gives to PWM ic
b) Two triggering outputs of 180° phase shift for MOSFET triggering. The output measure 210-220V AC at 50 hz as shown in figure b.
when fault we are seen that the fault current goes up to 300 amp.

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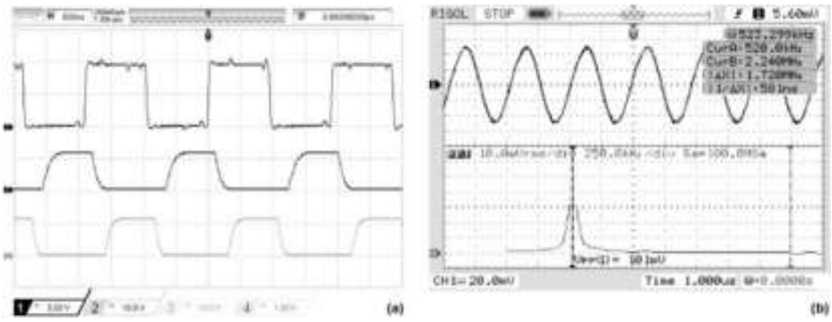

Fig 4: Output Waveforms

Experimental result:

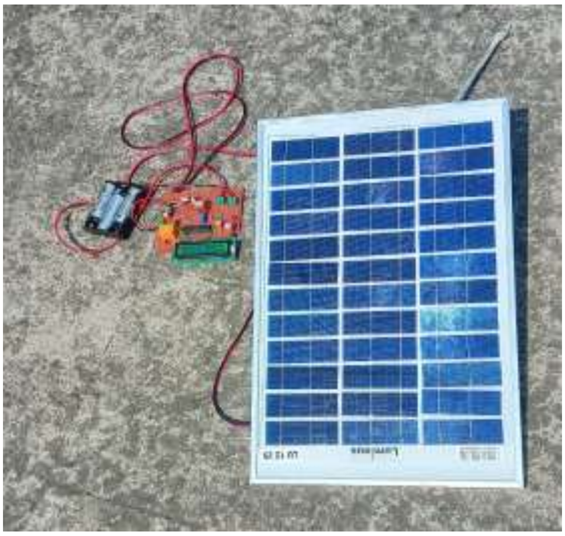

Fig 5: Experimental prototype

Future scope

Future modifications to this project can take many different forms. Although an Arduino Uno might be used in place of the pic microcontroller in this project. Future developments may include numerous sophisticated sensors. The precision and speed of fault isolation can be increased by utilising sophisticated sensors like synchro phasors and phasor measuring units (PMUs). These sensors enable quick and precise problem identification by providing real-time data on the voltage and current levels in the microgrid. This project focuses mostly on the Pic microcontroller, which is utilised the microcontroller in this project measures the current and voltage values, which are then displayed on the LCD. The current values on the solar panel, input from the converter, and battery voltage are also displayed on the LCD, but the biggest improvement we can make in the future is by using GSMR. The ability of GSMR to immediately detect faults and transfer information to the control centre is one of the key advantages of employing GSMR in fault detection and isolation. Faults in a DC microgrid can happen for a number of causes, including overloads, short circuits, and component failures for numerous functions including monitoring voltage and current values, sending tripping signals to relays when faults occur, and monitoring voltage and current values When a problem arises, the GSMR system can immediately identify it and transmit a warning signal to the control centre, allowing the operators to take the appropriate steps to isolate and fix the

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problem. A critical infrastructure like a DC microgrid requires a secure and dependable communication link, which is provided by GSMR technology The communication link can be used to track the performance of the microgrid's various parts, including the batteries, converters, and inverters, as well as to look for any irregularities or malfunctions. Advanced FDI algorithms must be created in order to precisely locate and isolate faults in DC microgrids. We can incorporate machine learning and AI, which will assist FDI algorithms be more accurate. Better fault isolation and detection can be achieved by using these techniques to create models that can learn from and adapt to the dynamic behaviour of DC microgrids. We can create an efficient microgrid by integrating one or more renewable energies. Using DC microgrids to incorporate renewable energy sources like solar and wind power is becoming more and more common. We can create an efficient microgrid by integrating one or more renewable energies. Using DC microgrids to incorporate renewable energy sources like solar and wind power is becoming more and more common. Due to the microgrid's potentially unpredictable behaviour, the integration of various sources creates significant difficulties for FDI. The development of FDI algorithms that can efficiently find and isolate flaws in these kinds of systems should be the main goal of future research

4. CONCLUSION

The primary goal of this project is to accurately identify and isolate from the DC micro grid a variety of defects that can arise in the system, such as short circuit, line to ground fault, and undervoltage, by diligent property monitoring of voltage and current values. The fault that arises in the system should be took away as soon as possible in order to maintain efficiency and reliability. The proper protection system is readily accessible for this purpose, and by tackling this project, we were able to find a solution to the issue. If any line is shorted to another line, the microcontroller detects the fault and sends tripling signals to the relay. The microprocessor is constantly tracking the values of voltage and current. Similar to the last example, when any line is connected to the ground, the microcontroller detects the issue and sends tripling signals to the relay. If the panel voltage is decreased below 6 volts, the sun's rays won't be as consistent for a longer period of time, which will affect the panel's efficiency. The microprocessor senses the panel's voltage and determines that it is below the value that was needed. This undervoltage state is established by the microcontroller. Due to its many benefits, photovoltaic power generation is becoming more significant as a source of renewable energy. These benefits include an endlessly pollution-free energy production plan, simplicity in maintenance, and direct conversion of solar energy into electricity. The cost of PV systems is still a barrier for this technology, though. Additionally, the PV panel's output power varies according to external factors like cell temperature and insolation levels. The system's outlined architecture will result in the project's desired output. From a DC source, the inverter will provide an AC source. The circuit's goal was to convert high-voltage DC sources or the output voltage of a DC-to-DC boost into AC power, similar to the kind that may be found in wall sockets and was only partially achieved.

5. REFERENCE

1. “A circuit analysis-based fault-finding algorithm for photovoltaic array under LL/LG

faults.” Ali Faisal Murtaza, Members, IEEE, Mohsin Bilal, Riaz Ahmad, Hadeed Ahmed Sher, Members, IEEE. VOL. 8, NO. 3 SEPTEMBER 2020.
2. “DC Microgrid Technology”. DINESH KUMAR1, (Member, IEEE), FIRUZ ZARE2, (Senior Member, IEEE), AND ARINDAM GHOSH3, (Fellow, IEEE). June 1, 2017, date of current version July 24, 2017. Digital Object Identifier 10.1109/ACCESS.2017.2705914
3. "An overview of DC-DC converter topologies and controls in DC microgrid". Shweta Dahale; Aakriti Das; Naran. M. Pindoriya; S. Rajendran 2017 7th International Conference on Power Systems (ICPS) Year: 2017 | Conference Paper | Publisher: IEEE
4. “Model-Based Fault Detection and Isolation in DC Microgrids.” Konstantinos F. Krommydas 2022 2nd International Conference on Energy Transition in the Mediterranean Area (SYNERGY MED) Year: 2022 | Conference Paper | Publisher: IEEE
5. “voltage-based protection for micro-grids containing power electronic converters” H. Al-Nasseri; M.A. Redfern; F. Li 2006 IEEE Power Engineering Society General MeetingYear: 2006 | Conference Paper | Publisher: IEEE
6. "Fault Detection and Isolation in DC Microgrids Using a Hybrid Bayesian Approach" by Wei Liu, Zhibin Zhao, Yan Chen, Jiafu Wan, and Chunhua Liu (IEEE Transactions on Power Electronics, vol. 33, no. 1, pp. 239-250, January 2018).
7. “A Model-Based Approach for Fault Detection and Isolation in DC Microgrids" by J. Su, Y. Sun, Z. Liu, and W. Wang, IEEE Transactions on Smart Grid, vol. 11, no. 2, pp. 1654-1665, March 2020.

