Analysis and Control Using IOT for an Differential Current Fault Protection with Adaptive Threshold Multiple PV-based DC Load

A. Balamurugan and B. Mohamed Nayas

Abstract--- The utilization of DC supply is for necessary power appropriation can bring a large plan, cost, and effectiveness advantages to the scope of intensity transmission and dispersion applications. The utilization of dynamic converter advances inside these systems is a key empowering agent for these advantages to be acknowledged; nonetheless, their combination can prompt uncommonly requesting electrical blame insurance prerequisites, both as far as speed and blame segregation. This paper depicts a novel new fault detection technique which surpasses the ability of numerous present assurance strategies so as to meet these prerequisites. The method utilizes fundamental characteristics of the converter filter capacitance's response to electrical system faults to estimate fault location through estimation of fault way inductance. Essentially, the technique has the capacity to identify and separate blame area inside microseconds of the fault happening, encouraging its fast expulsion from the system.

Keywords--- DC Bus, A Current Sensor, DC-DC Converter, Controller Application.

I. Introduction

Compared To high-voltage dc (HVDC) transmission systems, the dc dispersion system is a moderately new idea in Electric power frameworks. DC microgrids have numerous favorable circumstances over customary ac circulation frameworks. While air conditioning and dc microgrids require electronic control converters with a specific end goal to interface an assortment of sources to a typical transport, dc power as it requires fewer stages of conversion for both ac and dc output sources [1]–[3]. Moreover, for a given link, dc frameworks can convey times more power than the ac system. This is on account of the usable power depends on the RMS esteems in an alternating power supply, while the dc control depends on steady present and voltage. DC supply doesn't experience the ill effects of skin impact, which enables the current to move through the whole link, and not simply on the outer edge. This decreases losses and allows the dc system to use a smaller cable for the same amount of current [1], [4]. Ac micro grids have a reasonable preferred standpoint with regards to operational security. Ac power frameworks accompany over 100 long periods of experience and very much characterized benchmarks (e.g., ANSI/IEEE and IEC guidelines). The greater part of this can be effectively Converted into an alternating power grid. Guidelines on the assurance of dc system right now don't exist. Assurance gadgets for power supply are extremely developed, and they are for the most part significantly less expensive than dc breakers since they do not claim to fame things.

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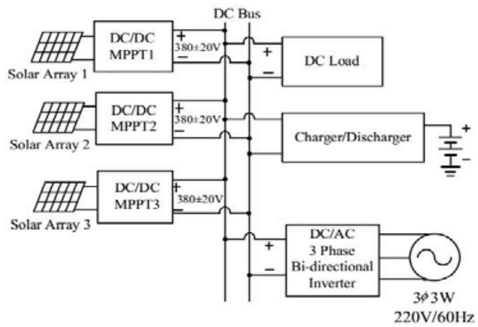

Fig. 1: HVDC Distribution Model

AC breakers rely on the natural zero crossings of the ac current; hence, these breakers cannot be applied in dc systems due to the lack of zero crossing in the DC. Modification to existing circuit breakers (CBs) is possible, but this drives up cost and lead times [5]. DC switchgear and CBs are expensive and may not always be available for certain systems [5]. A micro grid must have multiple terminals, and voltage source converters (VSCs) are generally used to interface individual sources to the dc bus because the classical line-commutated converters (LCCs) are extremely hard to use in anything other than point-to-point operations[6]. In any case, the insulated bipolar transistors (IGBTs) in a VSC lose control when blame happens on the dc transport, and the freewheeling diodes go about as a scaffold rectifier bolstering the Fault. The test related with the assurance of VSC-based microgrid frameworks is that the fault current must be identified and stifled rapidly as the Fault current withstand rating of ordinary VSCs is by, and large double the full-stack converter rating [6]. Semiconductor-based CBs have been researched, and they have been utilized for quick dc momentum interference and over current impediment [5], [7], [8]. Notwithstanding the Fault recognition and intrusion, finding the Fault in the transport is an essential procedure for quick recuperation from. The Fault. Even though the line impedance technique and voyaging wave strategy have been embraced as the business standard for AC systems [9], it is hard to specifically apply to dc frameworks because of the inherent nonattendance of recurrence and phasor parameters. This paper proposes a dc transport microgrid blame assurance technique including reinforcement security that enables the blame to be distinguished and detached without de-invigorating the whole framework. This is done using a ring transport with covering hubs and connections controlled by astute electronic gadgets (IEDs). Likewise proposed is a noniterative, deterministic Fault area system utilizing a test control unit. The data on Fault area is separated from the test current. The test control unit can likewise be utilized for a pilot test to decide if the blame is impermanent before fundamental CB reclosing to keep away from framework harm that can be normal when the fault is perpetual.

II. Literature Review

The Protection scheme for AC transmission systems is well understood and matured. On the other hand, the DC system is still facing a challenge in developing proper protection scheme because of its natural characteristics. A protection scheme, which utilizes some of the developed techniques for AC system, and modified to suit the DC system characteristics, is proposed in this. The system is based on the thought of DC current profile under transients, which depends on the fault location. This property is combined with the directional feature to achieve the protection of a DC micro grid. The proposed scheme is demonstrated on the ring type DC microgrid system, which is able to detect the fault in the DC system, and also ensure its backup protection. The proposed concept is verified and tested through simulations.

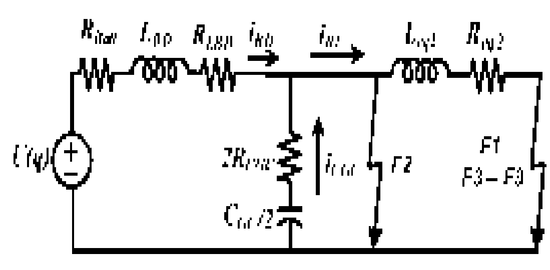

Fig. 2: Line Current Derivative

A low or medium voltage electrical system, comprising of conveyed assets, particularly sustainable wellsprings of vitality, storage devices, and burdens, are known as a

Microgrid. The electrical system can be AC, DC, or mixed, and may or may not be connected to the main grid. DC distribution network has the advantage of high-efficiency easy paralleling of sources on DC bus and more power transfer capacity. One of the primary difficulties in receiving the DC circulation system is the need to an effective solution to the fault protection. Protection system includes protective devices such as fuses, circuit breakers, load break switches, and relays. DC microgrid may consist of Voltage Source Converters in the network, which demands high-speed protection and isolation from the faulted organize. In view of the nearness of extensive DC capacitors and low impedance offered by the DC link, a fault in the DC system may come about into high transient current and voltages. The protection system should have the so-called property security and speed. It should also provide redundancy and dependability at the minimal cost. A protection scheme based on handshake signal method for Multi-Terminal DC system is reported in. In this scheme, as the fault is detected, all the VSCs are disconnected from the AC side, and the capacitors on the DC side support the load for short duration. As the system de-energizes, the load is dropped during the fault, which is not the desired situation. The results illustrate that the peak magnitude and the time of peak for the rate of change of fault current are the same for over and under damped fault conditions. This implies that the response is less dependent on the fault type, and makes fault discrimination difficult. Reference had investigated a range of protection solutions and reported that the differential current scheme is suitable for the DC system. Differential protection has the highest selectivity and only operates in case of an internal fault. Its operation would not be affected by the size and rating of the system components. But it requires a reliable communication channel for instantaneous data transfer between the terminals of the protected element. Because of chances to possible communication failure, differential protection will require a separate backup protection scheme. This increases the total cost and size of the protection system and limits its application in micro grids. The concept of the smart grid and microgrid requires sensors and communication networks to be provided in order to monitor the system condition and avoid outages. The communication may not be critical for monitoring functions, but if it is used for protection, and if fails it may result into system shutdown. Therefore, this proposes a scheme with primary and secondary protection based local measured system parameter characteristics that do not require any communication channel. To increase the system reliability and robustness, backup protection is also developed without using any communication channel.

III. PROPOSED ARCHITECTURE

A new differential current-based fast fault detection and accurate fault calculation are proposed for photovoltaic (PV)-based DC load. A multi-terminal direct current (MTDC) distribution network is studied as an adequate solution for present low-voltage utility grid scenario, where locally distributed generators (DGs) are incorporated primarily by power electronics based DC-DC converters, DC–AC voltage-source converters (VSCs). PV and are considered for cascaded common DC bus, and VSC unit achieves AC utility bus integration for the proposed MTDC network. DC micro load protection is quite significant research focus due to the absence of well-defined standards. Phase-to-phase, pole-to-ground, PV-side DC series and ground arc faults are considered as DC distribution network hazards. A discrete model differential current solution is considered to detect, classify and locate the faults by the modified cumulative sum average approach. A comprehensive case study is presented with different DC loadings, to the deliberate effectiveness of the proposed protection scheme in terms of percentage error and trip time.

Block Diagram

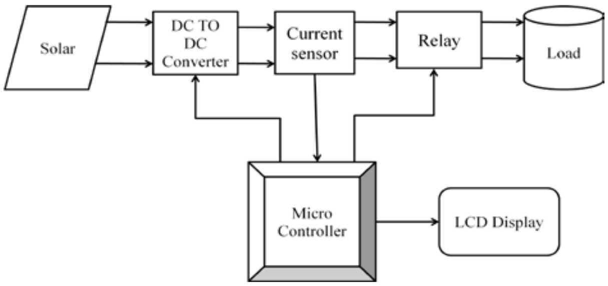

Fig. 3: Proposed System Block Diagram

Block Diagram Explanation

- A boost converter (step-up converter) is a DC-to-DC power converter that steps up the voltage from its input supply to its output load. Here cascaded dc-dc converter is used for improving the high efficiency of the circuit.
- A current sensor is a device that distinguishes electric current in a wire and creates a flag corresponding to that present. The created flag could be a simple voltage or present or even an advanced yield. The produced flag can be then used to show the deliberate current in an ammeter or can be put away to facilitating detection.
- Relays are switches that open and close circuits electromechanically or electronically.
- Relays control one electrical Relay are switches that open and close circuits electromechanically or electronically. Transfers control one electrical circuit by opening and shutting contacts in another circuit. As hand-off charts appear, when a transfer contact is regularly open (NO), there is an open contact when the hand-off isn't stimulated.
- Circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized.
- The microcontroller is used to varying the speed of the motor if high power flows the motor will be goes off condition by using a relay.

Photovoltaic Energy

The Word Photovoltaic Combines Two Terms–Photo Means Light And Voltaic Means Voltage. The Photovoltaic Energy Is Obtained From Sun Light In The Form Of Solar Energy. The Sun Light Is Made To Be Focused On Solar Panels Which Has The Ability To Convert The Solar Energy To An Electrical Energy. Solar Cells Of The Solar Panel do the Conversion Of Solar Energy To An Electrical Energy. A Sun based Panel Is a Set of Solar Photovoltaic Modules Electrically Connected and Installed on a Supporting Formation. A Photovoltaic Module Is a Packaged, Connected Assembly of Solar Cells. The Solar Panel Can be Applied as a Component of A a Larger Photovoltaic System to produce and Supply Electricity In Commercial and Residential Applications.

Types of Solar panels

There are four different types of solar panels. They are mentioned below:

- Polycrystalline
- Monocrystalline
- Hybrid
- All Black

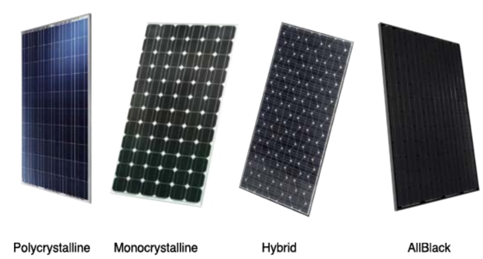

Fig. 4: Types of Solar Panels

Theory of Solar Cells

- Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon.
- Electrons are knocked loose from their atoms, allowing them to flow through the material to produce electricity, due to the special composition

of solar cells. The electrons are only allowed to move in a single direction.

- An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity.

Equivalent Circuit of Solar Cell

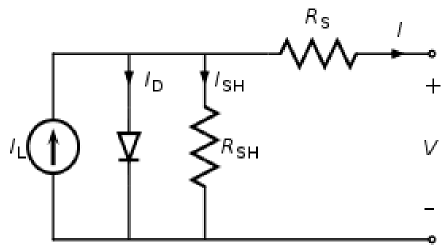

Fig. 5: Equivalent Circuit of Solar Cell

To comprehend the electronic conduct of a solar-powered cell, it is helpful to make a model which is electrically equal and depends on discrete electrical parts whose conduct is outstanding. A perfect sun oriented cell might be demonstrated by a present source in parallel with a diode; by and by no sun oriented cell is perfect, so a shunt obstruction and an arrangement opposition segment are added to the model. The subsequent identical circuit of a sun-oriented cell is appeared on the cleared out. Additionally appeared, on the right, is the schematic portrayal of a sunlight based cell for use in circuit outlines.

Buck-Boost Converter

This converter is an inverting DC-to-DC converter, i.e., the polarity of the output voltage is reversed compared to the input supply. Thus, it is a negative-output buck-boost converter.

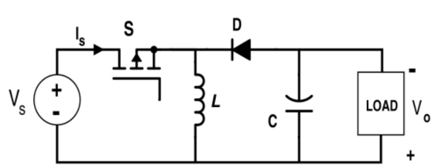

Fig. 6: Buck-Boost Converter

A boost converter (step-up converter) is a DC-to-DC power converter that steps up the voltage from its input supply to its output load. Here cascaded dc-dc converter is used for improving the high efficiency of the circuit.

Current Transformer

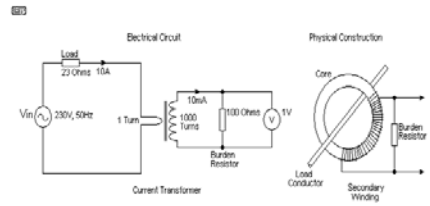

Fig. 7: Current Transformer

A current sensor is a device that detects electric current in a wire and generates a signal proportional to that current. The generated signal could be an analog voltage or current or even a digital output. The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis. The Generally current transformers and ammeters are utilized together as a coordinated combine in which the plan of the current transformer is, for example, to give a greatest optional current relating to a full-scale redirection on the ammeter. In most current transformers an inexact reverse turns proportion exists between the two streams in the essential and optional windings. This is the reason alignment of the CT is by and large for a particular sort of ammeter. Most present transformers have a standard optional rating of 5 amps with the essential and auxiliary streams being communicated as a proportion.

Relay

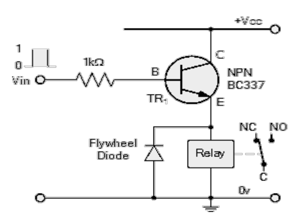

Fig. 8: Relay Circuit

Relay are switches that open and close circuits electromechanically or electronically. Relay control one electrical circuit by opening and shutting contacts in another circuit. As hand-off charts appear, when a hand-off contact is typically open (NO), there is an open contact when the transfer isn't empowered. The relay is the devices that open or shuts the contacts to cause the activity of the other electric control. It distinguishes the deplorable or bothersome condition with an allocated region and gives the orders to the electrical switch to disengage the influenced territory. Hence shields the system from harm. It gets a shot at the guideline of an electromagnetic attraction. At the point when the circuit of the hand-off faculties the Fault current, it energizes the electromagnetic field which produces the temporary magnetic field. The magnetic field moves the armature for opening or closing the connections. The small power relay has only one contact, and the high power relay has two contacts for opening the switch.

PIC Microcontroller Architecture

Peripheral Interface Controller (PIC) is microcontroller created by Microchip; PIC microcontroller is quick and simple to actualize program when we analyze different microcontrollers like 8051. The simplicity of programming and simple to interfacing with different peripherals PIC wound up proper microcontroller. We know that the microcontroller is an integrated chip which consists of RAM, ROM, CPU, TIMERS, and COUNTERS, etc. PIC is a microcontroller which also consists of ram, rom, CPU, timers, counter, ADC (analog to digital converters), DAC (digital to analog converter). PIC also supports the protocols like CAN,SPI, UART for interfacing with other peripherals.

PIC16F877A Introduction

The PIC Microcontroller Pic16f877a is one of the most Renowned Microcontrollers in the industry. This Controller Is Very Convenient To Use, The Coding Or Programming of this Controller Is Also Easier. One Of The main advantages Is that It Can Be Write-Erase as Many times as possible Because It Uses Flash Memory Technology. It Has A Total Number Of 40 Pins, And There Are 33 Pins For Input And Output. Pic16f877a Is Used In Many **PIC Microcontroller Project**. Pic16f877a Also Have Many Applications in Digital **Electronics Circuits.**

Pic16f877a Finds Its Applications In A Huge Number Of Devices. It Is Used In Remote Sensors, Security And Safety Devices, Home Automation And In Many Industrial Instruments. An **EEPROM** Is Also Featured In It Which Makes It Possible To Store Some Of The Information Permanently Like Transmitter Codes And Receiver Frequencies And Some Other Related Data. The Cost Of This Controller Is Low, And Its Handling Is Also Easy. Its Flexible and Can Be Used In Areas Where Microcontrollers Have Never Been Used Before As In Coprocessor Applications And Timer Functions Etc.

Pin Configuration and Description of PIC16F877A

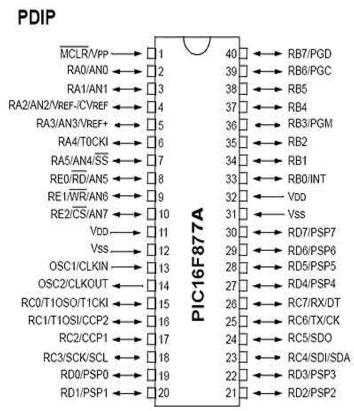

Fig. 9: Pin Configuration

LCD

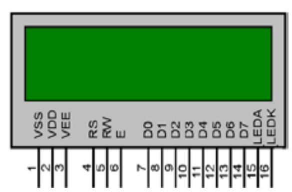

Fig. 10: LCD Display

The Flat screen LCD and plasma screens work in a completely different way. In a plasma screen, each pixel is a tiny fluorescent lamp switched on or off electronically. In an LCD television, the pixels are switched on or off electronically using liquid crystals to rotate polarized light. Short for liquid crystal display show, a kind of show utilized as a part of computerized watches and numerous compact PCs. LCD shows use two sheets of polarizing material with a fluid gem arrangement between them. An electric current went through the fluid makes the precious stones adjust with the goal that light can't go through them. A liquid-crystal display (LCD) is a flat-panel display or another electronically modulated optical device that uses the light-modulating properties of liquid crystals.

IV. Circuit Diagram

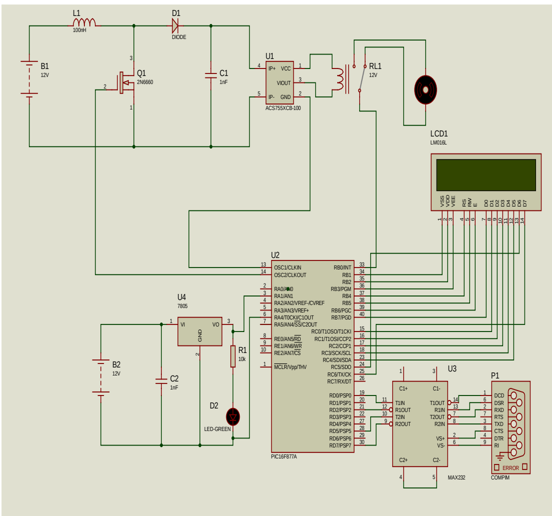

Fig. 11: Circuit Diagram for an Proposed System

Circuit Explanation

This project is the main concern for analyzing differential current analysis in the DC power source. Mainly the DC motor Based analysis has been taken for the entire system. Here +5v power supply is given to the microcontroller. The DC motor will be operated in the +12 v supply. The differential current is varied manually using a variable resistor. IF the current value goes high or low. The DC motor will stop immediately through the relay. That indication also monitored through IOT.

V. Result and Discussion

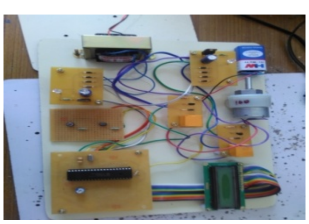

Fig. 12: Hardware Model for the Dc Motor Control

Hardware Output

Hardware	Specification	Input Ranges	Output Ranges
Solar	Input power	Solar rays	12V
Battery	Input power	12V	7.5A
Current sensor	Analyzer	(0-5)Amp	3AMP
RECTIFIER	Input power	12V AC	12 V DC
Load	Load	12V	100RPm
Microcontroller	PIC(16f877a)	5V DC	5V DC

Advantages

- The load-based fault current will be analyzed.
- Easy to protect load system.
- Identification for fault in a dc system is applicable.

Application

- Industrial motor control application
- Speed control by using various DC motor speed

VI. Conclusion

A new differential current-based fault detection and distance calculation scheme are for validating its effectiveness. The worst-case scenario is presented with DC arc (ground, series) faults when the PV system is absent from proper grounding. Trip time and percentage error are considered for efficiency calculation of the proposed approach. The proposed differential current-based protection method is effectively used for fast fault detection as well as accurate distance measurement as compared with and this non-iterative scheme is superior in comparison to the PPU-based protection by abolishing the requirement of extra equipment for fault distance measurement

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