USE OF INA219 SENSOR FOR LOCATING GROUND FAULT

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***Abstract*- DC power systems and stationary battery in switchgear and control applications are typically designed and operated as ungrounded systems which means that there is no intentional low resistance or solid connection to ground from either the positive polarity or negative polarity of the dc system. Ground faults happen when a current-carrying conductor makes unwanted contact with equipment grounding conductor, or any piece of metal that is grounded. This can occur through damaged conductor insulation or with improper installation. This is a potentially dangerous situation. This project module is used to detect multiple faults in DC system mostly connected to protective relays in Thermal Power Plant. The previous method which is in use is the Clamp Method. In this method, if a fault occurs a CRO is connected to the DC supply using a clamp and the fault is detected. This method is time consuming and non-economical while considering a huge number of DC circuits. Hence this project module overcomes the former method problems and automatically detects the various DC faults. The parameters like current, voltage and power values can be monitored during the normal condition and also during fault conditions. This monitoring process can be done using Blynk application server through mobile. In this project module the process of detecting the DC faults is done by using INA219 sensor, ESP8266 Wi-Fi chip and ESP32 Wi-Fi module. This module is versatile and can be used for any specified voltage range.**

***Keywords* – Leakage current, INA 219 DC current sensor, ESP 8266 Wi-Fi Chip, ESP 32.**

I. INTRODUCTION

The main function of electrical protection system is to detect and isolate the faults occurring in the power system. It also need to keep the power system working by isolating only the components that are under fault while leaving the rest of the network in operation. DC power is used to trip and close circuit breakers, turn turbines that are not in service and for running lubrication pumps on critical equipments like turbines. Some kind of power storage is required to bring the power generation station online i.e., to connect the generation station back to the grid, this process is called **"Cold Start"**. DC motors does this process quite well. The main function of an electrical protection system is to detect and isolate faults occurring in the power system. Similarly, it needs to keep the power system stable by isolating only the

components that are under fault, while leaving as much of the network as possible still in operation.

LITERATURE SURVEY

The various data collected from the below literature survey is quite useful in various ways for developing the project. In the same way each paper has its own advantage and disadvantage. In which some ways to overcome the drawback is being discussed in the design and implementation of DC ground fault detector. H. Morimoto (2015) discussed about the ground faults from positive conductors on fixed surface with relatively high resistance in DC system are problem since the fault current is weakest and also included the new idea of dealing the fault. .JA Marrero, (2000) discussed about the fault protection and location method for ungrounded dc traction power systems is presented in this paper. Many dc traction power systems have an ungrounded power circuit to increase the leakage path resistance. RK Kodali (2016) discusses about Owing to the ubiquitous availability of WIFI, all the appliances within home can be connected through a common gateway.
Electrical protection systems in geothermal power plants usually comprise the following four main items:

- Current and voltage transformers: to step down the high voltages and currents of the electrical power system to convenient levels for the relays to deal with.
- Relays to sense the fault and initiate a trip or disconnection order.
- Circuit breakers: to open/close the system, generally located so that each generator, transformer, bus and feeder can be disconnected from the rest of the system.
- Batteries to provide power in case of a power disconnection in the system.

II. TYPES OF UNGROUNDED DC SYSTEM

There are two types of DC systems,

i. **220**V DC system
ii. **24V** DC system

i. **220**V DC system - The 220V DC system supplies direct current as source of operating power for control**,** signaling**,** relays**,** tripping and closing of switchgears, emergency motors of most important auxiliary systems. Under normal conditions of station generation, the storage battery units are kept floating in DC bus bars by means of the trickle chargers (also known as float chargers). The trickle chargers of each battery unit, which is a rectifier with AC input, is normally made to take all DC requirements of the power station without allowing the battery to discharge. This is achieved by maintaining the DC output voltage of trickle charger a few volts higher than the voltage of the battery. The complete AC power system

failure in a power station is known as emergency situation. DC battery units are designed to supply station DC loads for an emergency period of one hour. The tickle charger normally supplies the station DC load and the momentary loads will also be catered for by the trickle charger and if such a load is more than its capacity, the battery being in parallel with the trickle charger will supply the excessive load.

ii. **24V** DC system - In a power plant, a lot of control circuitry will be there, which will be providing the data for monitoring and controlling in the control room. This power supply should not be interrupted at any cost for proper functioning of the plant and the electronics elements, which require less dc voltage. The main requirement is a 24V dc in power plant. The 24-volt dc supply is normally used to light up the digital meters that are seen in the control panels. Apart from that some of the other electronic devices in the panels also use this dc supply. It is sometimes used for the control circuit.

III. HARDWARE COMPONENTS

In this chapter we are going to discuss about the components used in the ground fault locator project and how each component works. The dc ground fault locator is done for 24V system.

i. **Relay** - Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical 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. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is not Energized .In either case, applying electrical current to the contacts will change the state .Relays are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps. Nonetheless, relays can "control" larger voltages and amperes by having an amplifying effect because a small voltage applied to a relays coil can result in a large voltage being switched by the contacts .Protective relays can prevent equipment damage by detecting electrical abnormalities, including over current, undercurrent, overloads and reverse currents. In addition, relays are also widely used to switch starting coils, heating elements, pilot lights and audible alarms.

ii. **Electromagnetic Relay** – Relays are either electromechanical relays or solid-state relays. In electromechanical relays (EMR), contacts are opened or closed by a magnetic force. With solid-state relays (SSR), there are no contacts and switching are totally electronic. The decision to use electromechanical or solid-state relays depends on an application's electrical requirements, cost constraints and life expectancy. Although solid-state relays have become very popular, electromechanical relays remain common. Many of the functions performed by heavy-duty equipment need the switching capabilities of electromechanical relays. Solid State Relays switch the current using non-moving electronic devices such as silicon-controlled-rectifiers. The differences in these relays result in advantages and disadvantages with each system. Because solid state relays do not have to either energize a coil or open contacts, less voltage is required to "turn" Solid State Relays on or off. Similarly, Solid State Relays turn on and turn off faster because there are no physical parts to move. Although the absence of contacts and moving parts means that Solid State Relays are not subject to arcing and do not wear out, contacts on Electromechanical Relays can be replaced, whereas entire Solid-State Relays must be replaced when any part becomes defective. Because of the construction of Solid State Relays, there is residual electrical resistance and/or current leakage whether switches are open and closed. The small voltage drops that are created are not usually a problem; however, Electromechanical Relays provide a cleaner ON or OFF condition because of the relatively large distance between contacts, which acts as a form of insulation.

iii. **ESP32** - ESP32 is a single chip 2.4 GHz WI-Fi and Bluetooth combo chip designed with TSMC ultra low power 40 nm technologies. It is designed and optimized for the best power performance, RF performance, robustness, versatility, features and reliability, for a wide variety of applications, and different power profiles. ESP32 is designed for mobile phones, wearable electronic devices and Internet of Things (IoT) applications. It has many features of the state-of-the-art low power chips, including fine resolution clock gating, power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario, ESP32 is woken up periodically and only when a specified condition is detected; low duty cycle is used to minimize the amount of energy that the chip expends. The output power of the power amplifier is also adjustable to achieve an optimal trade off between communication range, data rate and power consumption.

Application -

- Generic low power IoT sensor hub
- Generic low power IoT loggers
- Video streaming from camera
- Over The Top (OTT) devices
- Music players – Internet music players – Audio streaming devices
- Wi-Fi enabled toys – Loggers – Proximity sensing toys
- Wi-Fi enabled speech recognition devices
- Audio headsets
- Smart power plugs
- Home automation

iv. **ESP8266 -** ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface.

Application –

- Smart power plugs
- Home automation
- Mesh network
- Industrial wireless control
- Baby monitors
- IP cameras
- Sensor networks
- Wearable electronics
- Wi-Fi location-aware devices

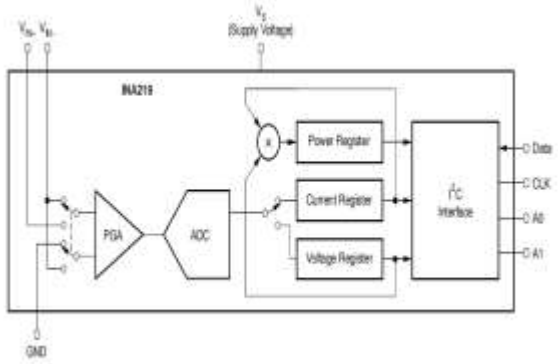
v. **INA219 Sensor** - The INA219B breakout board and the INA219 FeatherWing will solve all your power-monitoring problems. Instead of struggling with two multimeters, you can use this breakout to measure both the high side voltage and DC current draw over I2C with 1% precision. The board comes with all surface-mount components pre-soldered. Additional parts are included to help integrate the INA219 breakout board into your project. Wires can be soldered directly to the holes on the edge of the board. But for breadboard use, you will want to solder on the included 6-pin header. The load can be connected via the header, or using the included 2-pin screw-terminal.

Connections –

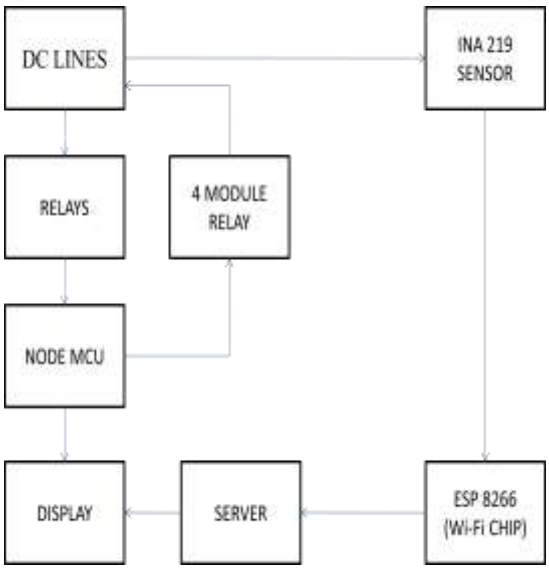
- Connect V+ to the positive terminal of the power supply for the circuit under test.
- Connect V- to the positive terminal or lead of the load.
- This puts the sense resistor in-line with the circuit.
- Finally, connect a wire from the negative terminal of the power supply to GND.
- This allows the sensor to measure the load voltage as well as the load current.

Arduino Code –

- Install the Library Download (https://adafru.it/aRj) the library (https://adafru.it/aRj) from the Downloads button below https://adafru.it/rMD https://adafru.it/rMD
- Expand the .zip file to the Libraries folder in your Arduino Sketchbook folder .
- Open File->Preferences in the IDE and it will tell you the location of your sketchbook folder.
- Rename the folder to Adafruit_INA219 Close all instances of the IDE, then re-open one, so that the IDE will recognize the new library.
- Load the Example Select
- "File->Examples-Adafruit_INA219>getcurrent" The "getcurrent" example code should open in a new IDE window.
- Click on the upload button in the IDE. When it is "done uploading".
- Open your Serial Monitor and set the speed to 115200 baud.



IV BLOCK DIAGRAM



V WORKING OF HARDWARE

When there is no ground fault the system runs smoothly, in every panel current entering is equal to current leaving and thus system functions normally without any problem. Now when the DPDT switch is pushes to the side where there is a particular line connected (say negative DC line) then the negative DC line gets connected to the earth, which means that the negative line is grounded. According to the type of fault the corresponding 24V Relay is activated and this sends the signal to the ESP32 and in turn the corresponding 5V relay is activated to connect the resistor to the circuit, so according to the opening of the relay the type of fault is decided by the ESP32 from the program uploaded. The other two relays in 5V 4-Channel Relay module is used for backing up the two 24V relays to normal condition i.e., to bring the System to normal condition after the fault is detected and rectified.

VI. OUTCOME

The DC fault is detected among many DC connections. The Relay in Automatically operated at the fault connection, isolating the faulty section from the healthy part of the power plant . The value of Current, Voltage and also Power in the fault connection can be observed using a desktop. Additionally the DC circuits can be monitored instantaneously. In a normally ungrounded DC system consisting of many circuits, detecting the place of faults takes

a lot of time. If detecting the place of the DC fault takes a lot time, then the protective system in thermal power plant may collapse and may lead to black out. In the former fault detection methods the healthy parts of system also gets disturbed.

VII RESULT

The output screen display using the Blynk application server is shown below with the voltage, current and power values.

(a) **B**efore Load

(b) **A**fter Load

After the application of the load there is increase in the power and current value as shown in the above figure. The load power obtained is 1160mW which is approximately 1Watt and the load current obtained is 32.92mA.

VIII. HARDWARE MODULE

IX. CONCLUSION

This project module thus detects -the fault by using the **INA219** DC current sensor and with the help of **B**lynk application sever it is displayed through the mobile phone. In the thermal power plant, mainly in the protection and control system this project module is useful and more essential while considering the operation of healthy system apart from the faulty system.

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