
Renewable Energy System with Preventive Mechanism for Smart Grid

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ABSTRACT

In recent days, the consumption of electrical energy by the consumers are increasing day by day. This is the case of consideration that production, transmission, distribution and utilization of energy must be done more efficiently by utilizing renewable energy sources to an extent to meet the needs, in doing this the protection of power system with synchronization of power supplies must be done more effectively to overcome the need of normal operating quantities and abnormal quantities with respect to voltage, current and frequency. Conventional structure grid with few renewable energy sources generalized for supplying power to the load. In this paper hierarchy proposed and regulated system utilizes local area distribution parameters. Solar and hydro power sources are employed for extracting the resources in the system. The reversible and secondary batteries like Li-ion, Ni Cad and lead acid batteries are used. The minimum voltage level of the cells in battery are continuously observed through potential track and microcontroller devices. In this paper the most available form i.e., solar energy is considered to meet the load requirement and at a specific time the Arduino based automatic control system is utilized to indicate the disturbance levels caused by the supply at regular intervals of time and supplying the power continuously without any block out.

Keywords: Microgrid, Smart grid, Smart grid Protection, Hybrid renewable energy sources, Microgrid Protection.

INTRODUCTION

Solar energy and hydro energy are at most crucial and clean sources available in abundance in nature. Harvesting maximum amount of renewable energy and utilizes them in times of emergency can be done [1]. It detects faults and clears them with less time and smart technology. Due to excessive use of nonrenewable energy sources, there is a dire need to use look for renewable energy. The main aim of our project is to harvest maximum amount of renewable energy and store them in batteries in form of electric current and utilize them for emergency loads. Maintaining essentials to satisfy increasing demand of power in future generations. The use of embedded at mega 328P is programmed by C programming before the chipset is withdrawn from the Arduino board [2-3].

The voltage sensor and current sensor is used to detect fault and switch on emergency load using inverter and relay circuit. By this way we can improve the efficiency and reliability of the system. Over-voltage and currents result in a power system when the system voltage and current rise over $\pm 10\%$ of the nominal base voltage and current. The electrical power system

generally suffers from over voltages and harmonics due to sudden switching actions at the load end.

The basic aim is to detect the over voltage and current and isolating the utility from the supply mains such that the utility does not get effected from any loss. The interruption to the over voltages and currents are achieved by regulating the trip coil of relay with Arduino. In general, residential, and semi-commercial loads are safeguarded for over-currents using fuse, circuit breaker and limited by protection against overvoltage and currents. The present paper illustrates to develop an over voltage and over current protective relay mechanism for residential and commercial electrical equipment's installation using Arduino at affordable and less cost. It detects potential and current values higher than pre-set one and it generates a trip signal which directs the MCB to isolate the utility from the source. It is also used protect loads from high impulse voltage and currents. Arduino based relay circuit can be also used for voltage and current lesser than the pre-set value and over current relay through coding. The characteristics like DT, IDT, IDMT and extremely inverse can be plotted.

OVER VOLTAGE AND CURRENT

The phrase over voltage and current is in use from 1907. According to IEEE standards, Overvoltage and current states "Voltage and current between one phase and ground or between two phases, having a crest value exceeding the corresponding crest of maximum system voltage and current." The fig.1 represents various abnormalities in the transmission system.

Classification of over voltage and currents: Depending on the time interval and the peak value of the voltage and current, over voltage and currents are categorized as

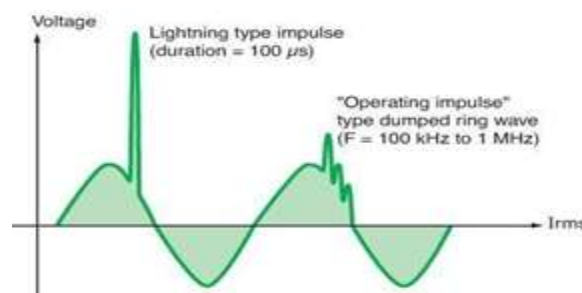


Fig. 1. Over voltage, impulse voltage, and transients

- 1) Lightning by direct stroke: A direct stroke is one where lighting hits the phase conductor.
- 2) Electromagnetically there will be induced over voltage and currents taking place near the pole conductor is called as side stroke.
- 3) Internal Over voltage or currents are caused due to variation in the operating conditions existing in power system.
- 4) External over voltage and currents results from lightning strokes, sudden drop of large loads and switching actions.

Transient over voltage and currents of higher frequency:

- 1) A fractional duration highly damped overvoltage and currents have fraction of msec or less is a transient. This results in an existing electrical network because of sudden switching actions.

- 2) When large loads are removed from the transmission line Ferranti effect has a greater impact on the network.

DESCRIPTION OF BLOCK DIAGRAM

The main objective of the protective device is to prevent the load from over voltages and overcurrent situations by regulating the relay trip coil with a controller [4-8]. The controller compares the system voltage and current and current with the predetermined voltage and current and it operates the trip coil in the relay circuit, if the input voltage and current falls above the pre-set range of values. If the voltage and current are within the specified limits, the utility is connected to the source. Else, the relay terminates the utility from the supply and prevents from rupturing. The fig.2 is the block diagram illustrates the devices used in the process.

A.C Input: The input AC supply energizes the device from the public utility. It is required for direct operation of contacts the relay and interlinks the utility to the grid when the potential is within 210V – 235V.

Step down transformer: The transformer is used step down the voltage to 5v on the secondary winding. So, it is a 230/5 V stepdown transformer. Any deviation in the primary winding affects secondary winding potential of transformer.

Rectifier: Full wave rectification is used by a center tapped transformer contains a capacitor to remove the harmonics. The smoothening and rectification done by the filter, a sample of the V_o and I is given to the Arduino. The transformer is designed to withstand over voltage and current w.r.t 600Vac. Arduino is a prototyping platform which is an open source. The comparison of the input deviations with the predetermined value is done and if the deviations are within the specified limits, then it directs the pin interconnected to the relay terminal is high. The relay circuit is then isolated with the command signal.

Relay: A relay senses any abnormal current quantities and redirects to make or break a switching contact. Relays employ an electromagnetic amplifier to operate a switch. Relay employed is single pole switch, which is directed by the Arduino which differentiates between normal supply quantities (V_s and I) and abnormal quantities. Its rating is 90mA 230v AC, 50 Hz. 5vDC.

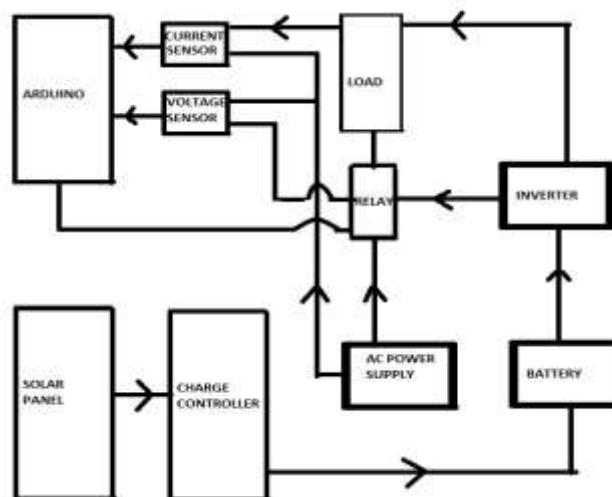


Fig.2. Block diagram for protective mechanism

Technical specifications of different batteries employed in hybrid systems are given in table 1.

Table 1: Technical Specifications of the Battery

Name	Comparison of specified commonly batteries				
	Li-Ion	Na-NiCl ₂	Ni-MH	Li-S	Unit
Maximum unit Charge	74	83	84	79	Ampere hour
Nominal potential	3.5 to 3.85	2-2.8	1.2-1.5	3-3.5	Volts
Energy stored	24	24	24	24	kWh

TRIP CIRCUIT ANALYSIS FLOW CHART

The definite time or inverse definite time characteristic relays are selected for the operation. A switching mode of operation is initiated for the selection of relay. In ON mode of the switch, it functions as a definite time relay and in OFF mode of the switch, it functions as inverse definite time relay. In case of DT relay, irrespective of peak value of the potential and current, the relay initiates after a desired time i.e., 5 sec. At the beginning a range of voltage and current is pre-set for the DT characteristics curve. The relay circuit trips by 5 sec if the potential and current values lie in this specified limit. When the isolation time i.e., 5 sec become zero, the relay protects the load by tripping. If the supply voltage and supply currents are restored back to base value or the predetermined value, then the trip time resets, and the relay stops its operation [9-10].

In case of inverse time relay. Here we have 2 reference voltage and currents v_{ref1} and v_{ref2} . We consider two cases whether

- 1) $V_{reference1} < V < V_{reference2}$
- 2) $V > V_{reference2}$

There are two case 1) if the voltage value lies into the $V_{ref1} < V < V_{ref2}$, the relay operates in (IDT) inverse time relay i.e., the trip time reduces with rise in the over voltage. If the voltage value lies in $V > V_{ref2}$, then it functions in (DT) definite time relay. The trip circuit analysis is explained through flow chart as shown in fig.3

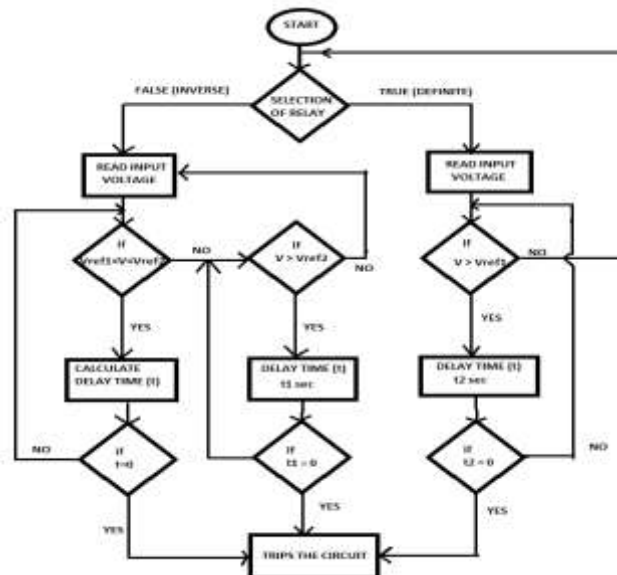


Fig. 3. Flow chart for Relay Operation

ADVANTAGES, DISADVANTAGES AND APPLICATIONS OF MICROGRID

Advantages

- 1) Improving local energy delivery
- 2) Increasing reliability
- 3) Energy consumed is limited, through a smart energy system
- 4) Generates revenue
- 5) Making grid more resilient

Disadvantages

- 1) Electrical parameters must be in acceptable limits
- 2) Requires more battery storage units
- 3) Synchronization of Grid

Applications

- 1) Microgrid integrates renewable energy sources in distribution networks with extensive distributed energy.
- 2) Electrical energy generated by renewable energy sources can be stored in batteries units or thermal energy storage systems.
- 3) Renewable energy has a high penetration of renewables.

RESULTS

Specification of different devices utilized in developing the project as indicated in fig. 4

- 1) Panel Rating of solar cells– (0-12V) DC, 0.5A (0-5W)
- 2) Battery capacity – (12-14V, 1A)
- 3) Trip Controller circuit – Atmega 328P
- 4) Protective mechanism of Relay – SPDT (5V)
- 5) DC to AC converter– 12V DC I/P, 180-230V AC O/P
- 6) Motor initializing driver – L293D IC
- 7) DC geared Motor – 0-10RPM



Fig. 4. Practical Model

An electrical power grid with renewable energy sources is an interline power flow network for delivering power from source to loads. It contains of power station that generate electrical energy, HV transmission system that transfer power from fossil fuel sources to demanded load centers, and distribution system that connect individual loads of customers. Power generating stations may be available near to an available fuel source where the scope of RES and are often available away from mostly populated areas.

Li-ion (LIB) batteries have high energy density and mostly commonly type at the utility end. These are different from Li primary batteries. A Li-ion uses intercalated Li compounds despite metallic Li as its electrode. These batteries can be commonly found in PDAs, iPods, cell phones, laptops.

- 1) A Li-ion can store 150 whr electricity per kg of battery, compared to 100 whr electricity in NiMH battery, and only 25 whr electricity in a lead-acid battery.
- 2) Li-ion usually lose 5-7% of their charge each month, against a 20-25% monthly loss for NiMH batteries.
- 3) Li-ion battery do not require full discharge prior to charging.

The battery storage capacity and its discharge time to transfer the power at the time of blackout/interruption in mains is given in table 2 and characteristics of discharge of battery in fig. 5.

Table 2: Battery Discharge Capacity

S.no.	Time (Min.)	Voltage (v)
1	0.00	13.6
2	0.06	13
3	0.10	12
4	0.12	11.5
5	0.17	7.5
6	0.20	7.2
7	0.24	5.1

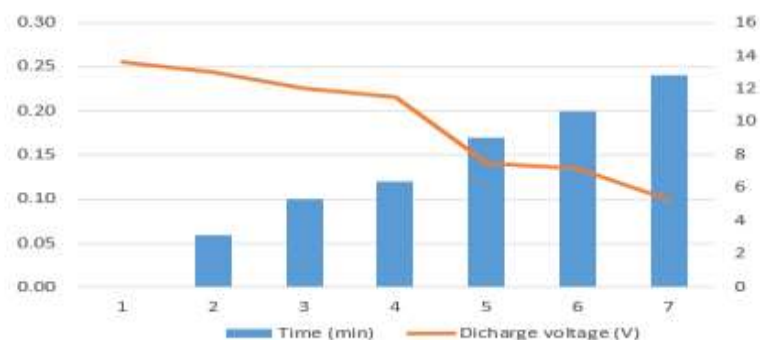


Fig. 5. Characteristics of discharge and time

CONCLUSION

The generated power is more stable, reliable and increases efficiency of the entire power system with microgrid and protects the utility. The system is much suitable for integrating the hybrid sources with existing power system. Our system successfully empowers A.C load using a solar panel. The system is based on Arduino Uno smart sensor which senses the faults related currents and voltages in turn protecting the system from block out/interruption thus reducing cost of entire system and increasing the efficiency.

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