Automatic System Balancing Using Special Protection Scheme, ROCOF and Under Frequency Protection

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Abstract: In a power system the generation has to be equal to the demand. If not, the system cannot be said to operate under effective condition. Suppose a sudden change occurs in load, it will be reflected in change in frequency. This can be determined by Rate of Change of Frequency (ROCOF). In Madakkathara, there are three 220kV feeders each can carry a maximum current of 750A.When load increases current exceeds beyond a limit, the person who used to monitor the current in the meter will open the feeder to reduce the current. This paper uses ROCOF to detect the frequency change in voltage and current from current transformer and potential transformer and the lines will be opened automatically by sending a trip signal to the respective relays. The frequency can be measured by detecting the zero crossing of voltage and current.

Keywords: ROCOF, Under Frequency, Feeders protection, substation

1. Introduction

For an efficient, reliable and secure operation of a power system the generated power should satisfy the demands. Any deviation from this balanced condition is known as power load imbalance. Power load imbalance is the most dangerous condition for power system operation. Overload condition in a power system generally leads to a fall in system frequency and at an extreme condition may result in system blackout. On driving an excess load it will slow down the operation of generator and prime mover. These load variations will also affect the distribution side. The usual solution to rescue the system from this sort of state is the load shedding, the aim of the work is to balance the system during variation in load. This proposed system is an automatic system balancing method in which under frequency load shedding schemes are used to return the system back to its normal state. The change in frequency is determined with ROCOF. It is determined by detecting the zero crossing of voltage waveform. In Madakkathara, there are three 220kV feeders each can carry a maximum current of 750A. Under overload condition the current limit will exceed for that particular feeder by our scheme a trip signal will be send to the substation which is fed from these if the overload condition persists for particular time limit set. When trip signal is send that particular load will be cut off and current will come under the limit.

2. Review

There are plenty of methods can be used to resolve the power shortage, one among them is islanding, but while forming islands it is very difficult to identify the actual demand of load and its variations[1-5]. A method to solve this is problem is with Vector Surge Relay(VSR), they can protect the Distributed Generators(DG's) on islanding, on having a surge, but for its operation it requires a greater range of active power, it is difficult to provide that much of active power [6-11]. This VSR cannot operate instantaneously, it need a long time to start its operation [12-18]. And if some asymmetrical faults occurs often then, the tripping of relay occurs continuously, on having coordination between multiple DG's it is risky to operate the system itself [19-23].

3. Hardware Description

Power load imbalance is the most dangerous condition for power system operation. Overload condition in a power system generally leads to a fall in system frequency and at an extreme condition may result in system blackout. The system integrates a microcontroller, astable multivibrator, switch and relays to perform the required load shedding during the imbalance.

4. Block Diagram

The figure 1 shows the block diagram of automatic system balancing using special protection scheme, ROCOF and under frequency protection.

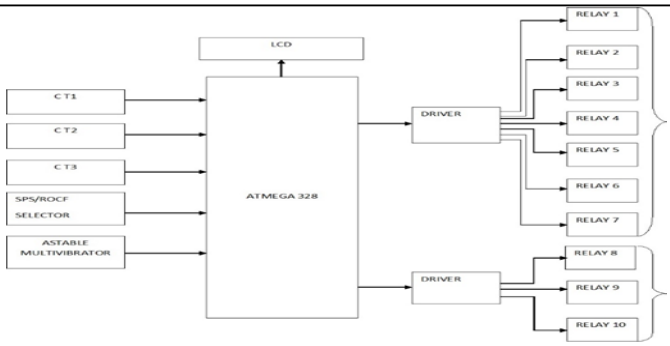

Figure 1. Block Diagram

4.2 Components used

4.2.1Microcontroller

High-performance Atmel 8-bit microcontroller is used. It combines 32 KB ISPflash memory, It can be reprogrammed easily due to its EEPROM nature, it have all necessary peripheral IC's like A/D converter, Timer, serial communication etc. The device operates between 1.8-5.5V. By executing powerful instructions in a single clock cycle, balancing power consumption and processing speed.

4.2.2 Current Transformer

Measuring the high current in the feeders is not possible with the normal range of meters, so it needs extensions for this purpose the Current Transformer (CT) is used, it is a step-up transformer which rises the value of voltage thereby decreases the current measurable by the normal ammeters

4.2.3 Liquid Crystal Display (LCD)

CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption. Here a 16x2 LCD display is employed for its low cost.

4.2.4 Astable Multivibrator

An Astable Multivibrator is a device that switches between two states. It is a type of oscillator and can be used as a trigger, converter, moderator, or divider. It usually produces changes in a system at timed intervals, depending on the number and placement of resistors and other elements within the system as well as the input signal's intensity. An astable multivibrator does not rest in an unstable state like other multivibrators, but continuously switches between two states.

4.2.5Electromagnetic Relay

Relays plays the important role in this system, the connection and disconnection of feeders depending upon the load consumption is performed by acting as a switch. It consists of a coil and a movable contact connected to spring. When an electric current is passed through the coil it generates a magnetic field that activates the coil, which attracts the movable contact and the consequent movement of the movable contact to make or break.

5. Working

The prototype created and tested with 10 relays connected to different feeders, and the change in frequency is analysed from each feeder, on having increase in load the frequency increases and while the load decrease, the frequency decrease, based on this phenomenon and the conditions of substation, a modal is designed and tested. Later the procedure is implemented in Madakkathara.

5.1 Details From Madakkathara

High-performance Atmel 8-bit microcontroller is used. It combines 32 KB ISPflash memory, It can be reprogrammed easily due to its EEPROM nature, it have all necessary peripheral IC's like A/D converter, Timer, serial communication etc. The device operates between 1.8-5.5V.

By executing powerful instructions in a single clock cycle, balancing power consumption and processing speed

5.2 Condition applied

(1) Condition1: If any one of the above 220kV feeder trips, and the load on the other two feeders equal to or greater than the below load condition.

(2) Condition 2: If 220kV Madakkathara to Malaparambu feeder load equal to or greater than 670A and for particular sec as condition 3 (OR) 220kV Madakkathara to Shoranur feeder load equal to or greater than 700A and persist for a particular sec as condition 3. (OR) 220kV Madakkathara to Areakkode feeder load equal to or greater than 700A and persist for a particular sec as condition 3.

(3) Action: If both condition 1&2 satisfies trip signal has to be generated from Madakkathara to trip the feeders. Trip signal can be transmitted from Madakkathara to remote substation using protection coupler in the following stages:

Table 1 Trip Signal Transmitted

Stages	**Triggering criteria for SPS if both 1 & 2 condition satisfies trip signal has to be initiated**	**Peak Load relief obtained**	**Affected Substations**	**Signal transmitted from**

	Condition 2	**Condition 3**	**in MW**		**MDKA to**
1	2MDMR>=670A (or) 2MDSH>=700A(or) 2MDAR>=700A	Persist for 0.75 sec	116	110kV Edappal and Koottanad, Koppam	220kV Shoranur& 220kV Malaparambu
2	2MDMR>=670A(or) 2MDSH>=700A(or) 2MDAR>=700A	Persist for 1 sec	80+116 (stage 1) =196	110kV Mundayad, Pinarayi, Thalasseri, Chovva	220kV Kanhirode
3		Persist for 1.5 sec	50+196 (stage 2) =246	110kV Mangad ,Azhikode&110 kV Payyangadi& 110kV Payyannur	220kV Thaliparambu
4	2MDMR>=670A (or) 2MDSH>=700A(or)	Persist for 2 sec	90+246 (stage 7) =336	110kV Malappuram	220kV Malaparambu&220kV

2MDAR>=7	Areak
00A	kode

6. Circuit Diagram

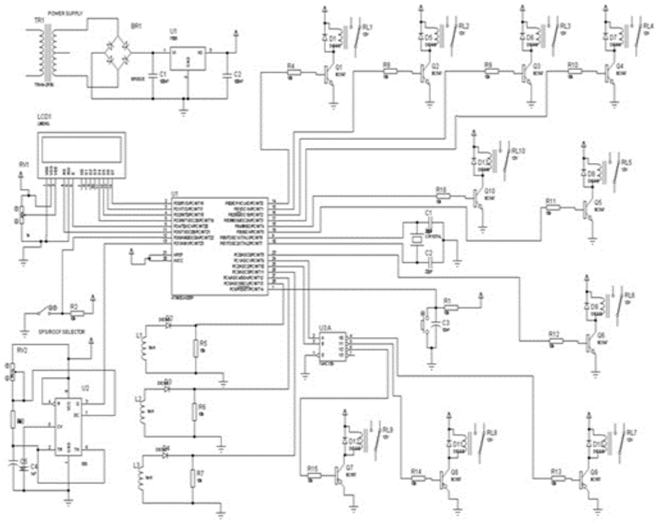

Figure 2: Circuit Diagram

The complete system is operated at 16MHz, the operating range of microcontroller used here is 5V DC, for obtaining this 5V the voltage is stepped down by a step-down transformer from 230V AC to 12V AC, which is then rectified to DC using a rectifier, the rectified DC contains ripples, in order to remove this ripples a capacitor is used and followed by that LM7805 voltage regulator to produce a constant 5V is used.

The current sensors are connected to these ADC pins the sample current is collected using half wave rectifier and a filter with load resistor circuit. The LCD is an external module used to display the details to the user. The LCD communicates with the microcontroller using parallel communication of the data. The data lines are connected to a port of the microcontroller and the control lines RS (register select), E (enable), R/W (read /write) is connected to the corresponding pins. Relays will act as a Single Pole Double Throw (SPDT) switch to make or break the circuit on having increase in current/ frequency level. A transistor driver uses the transistor as a switch rather than an amplifier by saturating the inputs and outputs.

7. Conclusion

Here an automatic system balancing system using ROCOF and under frequency protection to prevent load imbalance is developed and implemented. Using ROCOF and under frequency protection relays it is possible to detect the change in frequency from the normal values. In the existing system, the operator has to always check the ammeter and should monitor the load changes between generation and distribution side. As it was performed manually it was highly risky, this drawback overcomes by automatic system balancing. Current carrying capacities for seven feeders were fixed early. As load increases, feeder gets cut off according to the time delays set before. Thus this new system introduced in Madakkathara substation, to prevent blackouts in outgoing feeders of North Kerala. The ROCOF and under frequency relays are most efficient. Thus by using ROCOF and under frequency protection load in generation and distribution side is maintained equal.

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