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Microcontroller Based Over/Under Frequency Relay

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ABSTRACT

This paper investigates the frequency fluctuation in power system and protects the power system from its harmful effects. Therefore we design a Microcontroller Based Under/Over Frequency Relay. In this paper we use microcontroller dsPIC30F4011 for protecting the power system from the problem of frequency fluctuation. When frequency goes below or above from desired value then electromagnetic relay trip and isolate our power system from its harmful effect. Electromechanical protective relays operate by either magnetic attraction, or magnetic induction. Frequency Variation also decreases the life of the equipment and directly affects the overall production of the plant.

Keywords: Frequency Relay, Microcontroller, Trip, CMOS Technology ULN2003

I. INTRODUCTION

During severe emergencies which result in insufficient generation to meet load, an automatic load shedding program throughout the affected area can prevent total area collapse. It also helps to achieve fast restoration of all affected loads. This paper describes the factors involved in applying under frequency and over frequency relays to achieve a desired "deficient generation" protection level and a calculating method to achieve optimum relay settings.

When generator operates with under frequency and over frequency mostly its speed matches with resonance frequency which causes high vibration in generator and turbine. So generator do not operates with under frequency. Under overloading condition the generator will slow down to try to accommodate the extra load, this will result in overheating of stator windings, while also under this condition (under frequency) some equipment can be damaged. A load shedding scheme using dedicated frequency sensing relays will trip (disconnect) a set of load from the grid to recover from under freq and stabilize the system avoiding damage to generator and connected equipments.

II.NEED OF MAINTAINING FREQUENCY CONSTANT

Constant frequency is to be maintained for following functions:

1. All ac motors require constant frequency supply to maintain constant speed.
2. For synchronous operation of various units in the power system network, it is necessary to maintain constant frequency.
3. Frequency affects amount of power transmitted through interconnected lines. So it necessary to maintain constant frequency.
4. Electrical clocks will lose or gain time if they are driven by synchronous motor and accuracy of clocks depends on frequency.

III. DESCRIPTION OF BLOCK DIAGRAM

We can give an overview of complete operation with the help of microcontroller dsPIC30F4011, Electromechanical relay, driver ULN2003 etc.

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In this block diagram microcontroller(dsPIC30F4011) for control card gets two supply one is the main power supply for their operation and other is the input main ac for variation in frequency. LCD display the operating frequency. Driver is used for driving the relay, LED and buzzer. When frequencies goes less or above from our desired value then relay trips in respond to which LED start glowing and buzzer start producing noise to aware operators.

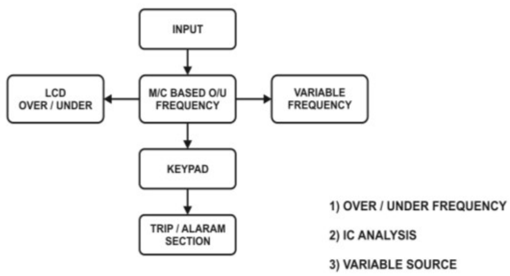


Fig: 1. Block Diagram of Over/Under Frequency Relay

IV. POWER SUPPLY

The power supply circuit consists of a bridge rectifier with shunt capacitance filter. A 5 volts regulated source is used for the entire circuit. Three terminal voltage regulators IC 7805 is used to provide 5 volts supply.

A.NEED OF POWER SUPPLY

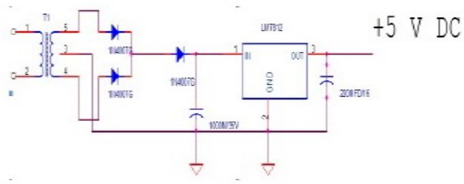
Perhaps all of you are aware that a 'power supply' is a primary requirement for the 'Test Bench' of a home experimenter's mini lab. A battery eliminator can eliminate or replace the batteries of solid-state electronic equipment and the equipment thus can be operated by 230v A.C. mains instead of the batteries or dry cells. Nowadays, the use of commercial battery eliminator or power supply unit has become increasingly popular as power source for household appliances like transreceivers, record player, cassette players, digital clock etc.

A.USE OF DIODES IN RECTIFIERS

Electric energy is available in homes and industries in India, in the form of alternating voltage. The supply has a voltage of 220V (rms) at a frequency of 50 Hz. In the USA, it is 110V at 60 Hz. For the operation of most of the devices in electronic equipment, a dc voltage is needed. For instance, a transistor radio requires a dc supply for its operation. Usually, this supply is provided by dry cells. But sometime we use a battery eliminator in place of dry cells. The battery eliminator converts the ac voltage into dc voltage and thus eliminates the need for dry cells. Nowadays, almost all-electronic equipment includes a circuit that converts ac voltage of mains supply into dc voltage. This part of the equipment is called Power Supply. In general, at the input of the power supply, there is a power transformer. It is followed by a diode circuit called Rectifier. The output of the rectifier goes to a smoothing filter, and then to a voltage regulator circuit. The rectifier circuit is the heart of a power supply.

C. FILTRATION

The rectifier circuits we have discussed above deliver an output voltage that always has the same polarity: but however, this output is not suitable as DC power supply for solid-state circuits. This is due to the pulsation or ripples of the output voltage. This should be removed out before the output voltage can be supplied to any circuit. This smoothing is done by incorporating filter networks. The filter network consists of inductors and capacitors. The inductors or choke coils are generally connected in series with the rectifier output and the load. The inductors oppose any change in the magnitude of a current flowing through them by storing up energy in a magnetic field. An inductor offers very low resistance for DC whereas; it offers very high resistance to AC. Thus, a series connected choke coil in a rectifier circuit helps to reduce the pulsations or ripples to a great extent in the output voltage. The fitter capacitors are usually connected in parallel with the rectifier output and the load. As AC can pass through a capacitor but DC cannot, the ripples are thus limited and the output becomes smoothed. When the voltage across its plates tends to rise, it stores up energy back into voltage and current. Thus, the fluctuations in the output voltage are reduced considerable. Filter network circuits may be of two types in general: Choke Input Filter, Capacitor Input Filter.



V. CIRCUIT DIAGRAM

We can see the complete operation of this paper with the help of this circuit diagram.

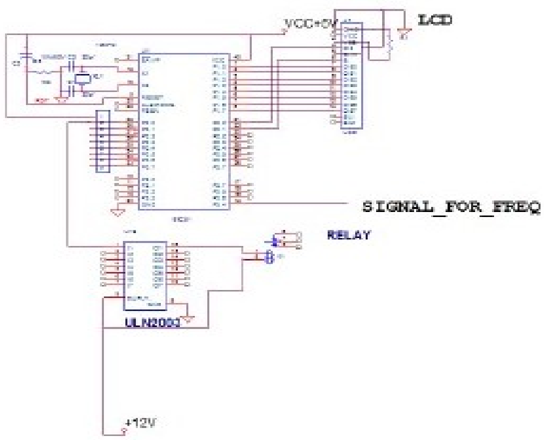


Fig: 2. Circuit Diagram of Over/Under Frequency Relay

Fig: 3. Picture of Over/Under Frequency Relay

VI. DECRIPTION OF MICROCONTROLLER dsPIC30F4011

Microcontroller dsPIC30F4011 which are used for controlling the frequency deviation. The dsPIC30F4011 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the indus-try-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel dsPIC30F4011 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The dsPIC30F4011 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the dsPIC30F4011 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM con-tents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

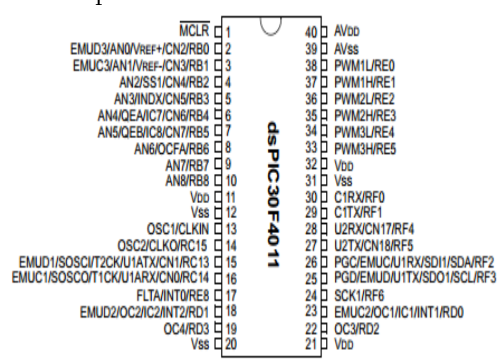


Fig: 4. Pin details of Microcontroller dsPIC30F4011

VII. RELAY

A relay is an electrical switch that opens and closes under the control of another electrical circuit In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered, in a broad sense, to be a form of an electrical amplifier. When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. . When the current to the coil is switched off, the armature is returned by a force approximately half as strong as the magnetic force to its relaxed position. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

VIII. POLE AND THROW

SPST – Single Pole Single Throw These have two terminals which can be switched on/off. In total, four terminals when the coil is also included SPDT - Single Pole Double Throw. These have one row of three terminals. One terminal (common) switches between the other two poles. It is the same as a single change-over switch. In total, five terminals when the coil is also included DPST - Double Pole Single Throw These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil In total, six terminals when the coil is also included. This configuration may also be referred to as DPNO

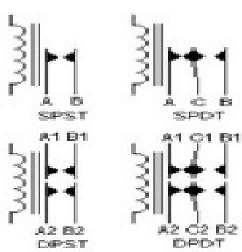


Fig: 5. Circuits symbols of relays

The contacts can be either Normally Open (NO), Normally Closed (NC), or change-over (CO) contacts.

IX. APPLICATION

Frequency relays are used whenever deviations from nominal system frequency need to be detected. Frequency deviations can be harmful to connected objects, such as generators and motors, or when abnormal frequency creates inconvenience for power consumers and may cause failures of electrical apparatuses. Frequency relays are also used where detection of high or low frequency indicates system abnormalities, such as faults in speed regulation units or system overload. Under frequency relays should be considered for applications where the detection of under speed conditions for synchronous motors and condensers is required. On lines where reclosing of the source breaker is utilized, damage to large synchronous motors can be avoided by disconnecting the motors from the system. Likewise, disconnection of synchronous condensers can be initiated upon loss of power supply. The over frequency relay is generally utilized for the protection of ac machines from possible damage due to over speed conditions. These conditions can occur, for example, on machines with no mechanical governor or on those with the machine shaft linked to a prime mover or to another machine, either one of which could accelerate the combination to a hazardous over speed condition (e.g. a hydro generator).

X. RESULTS

The relay is tested under different test conditions. These tests conditions are given below. Case 1 is over-frequency case, while Case 2 is under-frequency case.

Case 1: Over-Frequency

In the first case, the load is shed in two stages. Initially from 190MW to 150MW at 70sec, later on further load shed of 70MW is made at 120sec and the relay behaviour is observed. Fig. 6 represents the relay status under different load conditions.

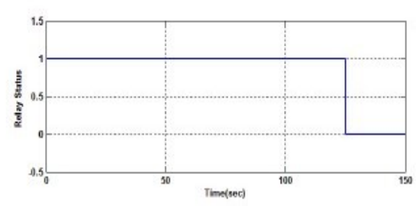


Fig 6. Relay Status

In first stage the relay does not trip. However a huge decrement in load of 70MW results in relay tripping. Fig.

7 represents the behaviour of electrical frequency.

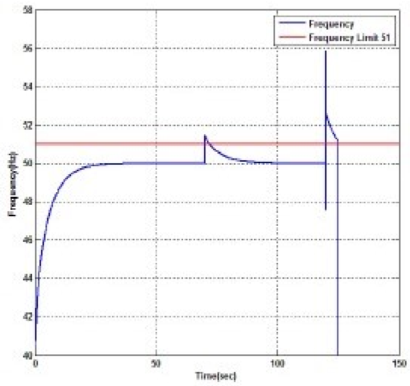


Fig. 7. Output Frequency

Case 2: Under-Frequency

In this case, 40MW is added at 70 sec in addition to base load of 150MW. Later on further load shed of 50MW is done at 120sec. Fig. 8 represents relay status under different load conditions.

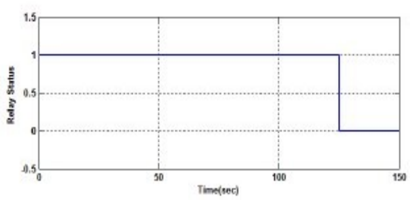


Fig 8. Relay Status

XI. CONCLUSION

At last we would like to conclude this paper under the guidance of highly capable mentor along with group members. Basically it is not just a paper it is the need of our initiative should be taken up to implement this practically in the college environment and the research is continued further by the students with maintenance. Future aspects of this paper is to be mainly used in chemical industries, protection of transformers and generators in power system which might badly affected by frequency variation .Also the life and performance of equipment suffers due to frequency variation.

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