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Low Cost Solution for Overload Protection

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Abstract: **Generating stations, transmission lines and the distribution systems are the main components of an electrical power system. Generating station and a distribution system are connected through transmission lines. A Power system network may suffer from faults, fault may occur on synchronous generator, bus bar, transmission line, transformer or load. It is important to take precaution for protection of Power system network against faults. It is often seen that during experimentation in the laboratory, circuits are burned out due to excessive current and overload. To prevent this from happening we designed a low cost protection system against over load and excessive current, for this we used electro-magnetic relay in conjunction with IC-LM324 and a 555 timer and designed a circuit in which, when excessive current flows it get disconnected thus keeping the circuit safe. Since in the above circuit the relay has to reset manually after every tripping, we designed another circuit which is reset automatically using the same IC-LM324 and a 555 timer only this time 555 timer works as a pulse sequencer. This acts a phase shifter, which when overload trips and continue to work with the previous load before overload fault occurs by drawing supply from a different phase thus the circuit keeps on working even after fault occurs.**

Keywords: **Low cost, overload, protection, solution, over current, over voltage.**

I. INTRODUCTION

The main objective of protecting the power system is to provide quick isolation to electrical circuit by detecting the fault part and to minimize the shock and to keep the contact as long as possible. On contrary there is one thing to clarify that that term protection in protective relay doesn't mean it can prevent problems(errors, fault, shock or any discepencies etc.,) It signifies that it will work only after any abnormal conditions had occurred. It is used to minimize the duration of problem, limitation of damages etc.

1.1 General Introduction:

The main objective of protecting the power system is to provide quick isolation of the power system's area with fault , in order that shock in the rest of system to be minimized and to be intact for as long as possible. In this context, there are five basic aspects of the protection relay application.

Before we talk for them, it should be noted that the use of the term protection does not mean that protective equipment can prevent problems, such as errors and equipment failures or electrical shocks due to unintentional human contact.

It cannot predict problems. Protection relays operateonly after an abnormal or intolerable situation that has occurred. This protection does not mean prevention, but rather, minimizing the duration of the problems and limitations of damages, the time of interruption, and similar problems.

Five basic aspects of protection relay application are:

1. Reliability: security that protection will function correctly.

2. Selectivity: maximal continuity of service with minimum disconnection system.

3.The speed of operation: the minimum duration of the fault, damage to equipment and system instability.

4. Simplicity: minimum protective equipment and related circuits to achieve the objectives of protection.

5. Economy: maximum protection with minimum cost.

1.2 Faults:

Power System Fault may occur on Synchronous generator, bus-bar, transmission line, transformer and load. Fault are more common on transmission line but less common on synchronous generator. With respect to transmission line, fault are classified into:-

Open circuit or series fault: Open circuit fault may occur due to melting of the fuse or breaking of Circuit breaker contact or snatching of the conductor, it may occur in single phase or may occur in two or three phase.

Open circuit faults of three phase will act as system is working under no-load from supply hence it is not treated as a fault. Current carrying elements, always employed with on the surface to prevent current flow from one surface of the conductor to other, to avoid short circuits.

If insulation current is flowing from one surface to ground or one surface to another surface, it leads to short circuit faults.

Short circuit or shunt fault: This faults generally occur due to falling of tree branches on overhead lines, failure of insulation, failure of insulation is most common compared to any fault mentioned before and thus Short circuit fault is more common in power system

Symmetrical faults: In such types of faults, all the phases are short-circuited to each other and often to earth. Such fault is balanced in the sense that the systems remain symmetrical, or we can say the lines displaced by an equal angle (i.e. 120° in three phase line). It is the most severe type of fault involving largest current, but it occurs rarely. For this reason balanced short- circuit calculation is performed to determine these large currents.

Unsymmetrical faults: Unsymmetrical faults involve only one or two phases. In unsymmetrical faults the three phase lines become unbalanced. Such types of faults occur between line-to-ground or between lines. An unsymmetrical series fault is between phases or between phase-to-ground, whereas unsymmetrical shunt fault is an unbalanced in the line impedances. Shunt fault in the three phase system can be classified as;

- Single line-to-ground fault (LG).
- Line-to-line fault (LL).
- Double Line-to-ground fault (LLG).
- Three-phase short circuit fault (LLL).
- Three-phase-to-ground fault (LLLG)

In single line-to-ground fault, one conductor comes in contact with the ground or the neutral conductor. A line-to-line fault occurs when two conductors are short circuited. A double line-to-ground fault occurs when two conductors fall on the ground or come in contact with the neutral conductor. LG, LL, and LLG are unsymmetrical fault while LLL and LLLG are the symmetrical faults. For this reason, balanced short-circuit calculation is performed to determine these large currents.

II. FAULT PROTECTION

2.1 Fault Protection using Relay circuit:

What is protection relay?

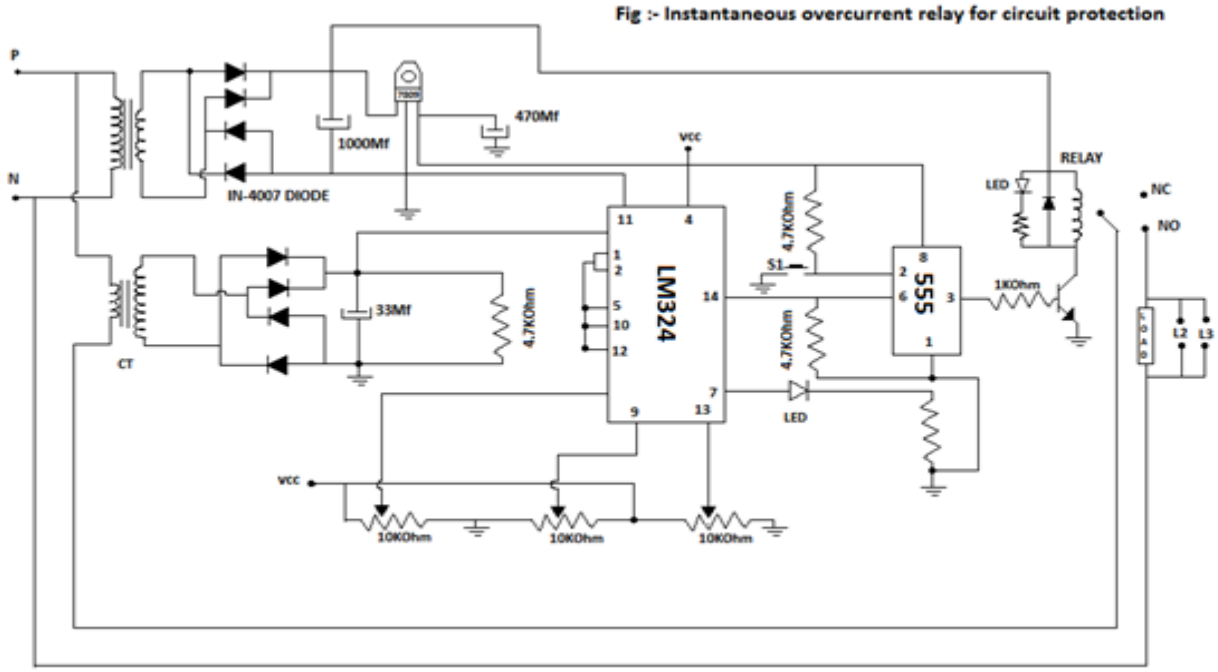
Protection relay is a sensing device that receives data compares them with reference values, and delivers results. Incoming data can be current, voltage, resistance or temperature. Results can include visual information in the form of indicator lights and/or an alphanumeric display, communications, control warnings, alarms, and power on and off.

Overcurrent Protection:

Transmission and distribution systems are exposed to overcurrent flow into their elements.In an electric power system, overcurrent or excess current is a situation where a larger than intended electric current exists through a conductor, leading to excessive generation of heat, and the risk of fire or damage to equipment. Possible causes for overcurrent include short circuits, excessive load, transformer inrush current, motor starting, incorrect design, or a ground fault. Therefore, for normal system conditions, some tools such as demand -side management, load shedding, and soft motor starting can be applied to avoid overloads. In addition, distribution systems are equipped with protective relays that initiate action to enable switching equipment to respond only to abnormal system conditions. The relay is connected to the circuit to be protected via CTs and VTs according to the required protection function.In order for the relay to operate, it needs to be energized. This energy can be provided by battery sets (mostly) or by the monitored circuit itself.

2.2 Circuit diagram:

Fig :- Instantaneous overcurrent relay for circuit protection



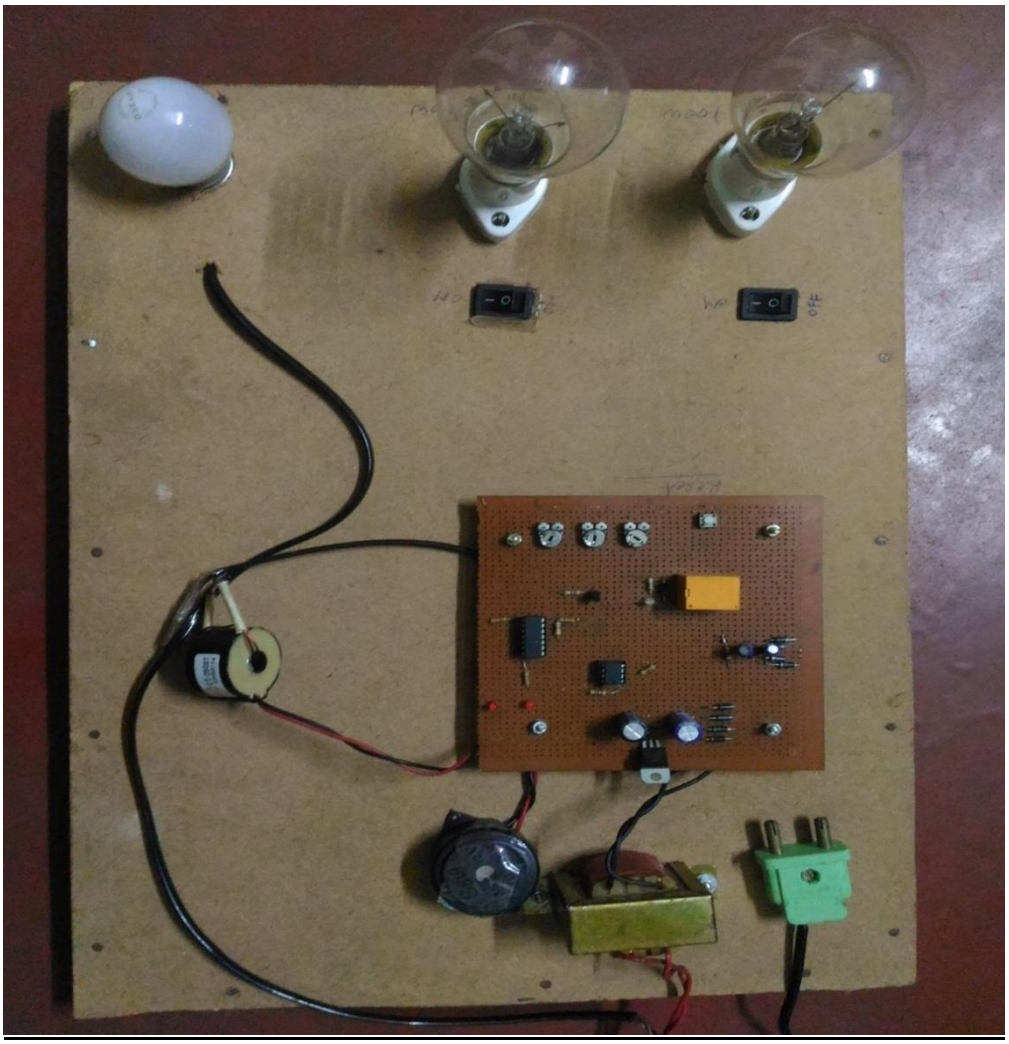
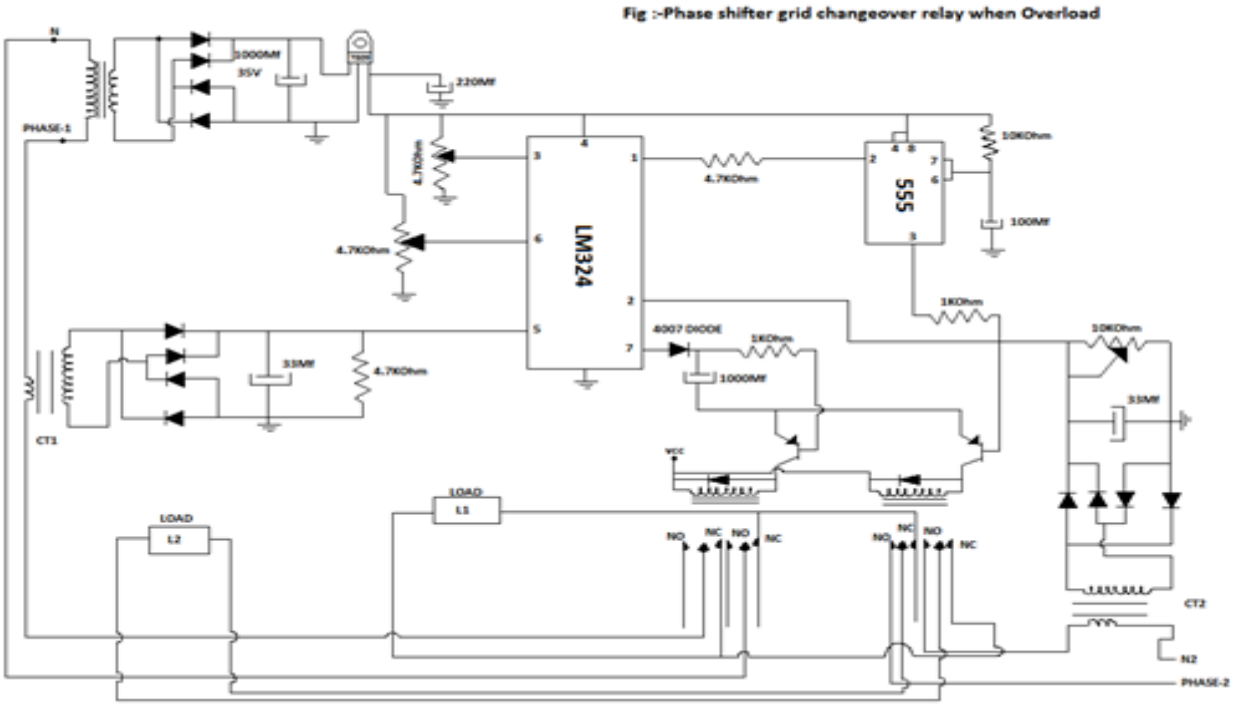


Fig 1: Instantaneous over current relay for circuit protection



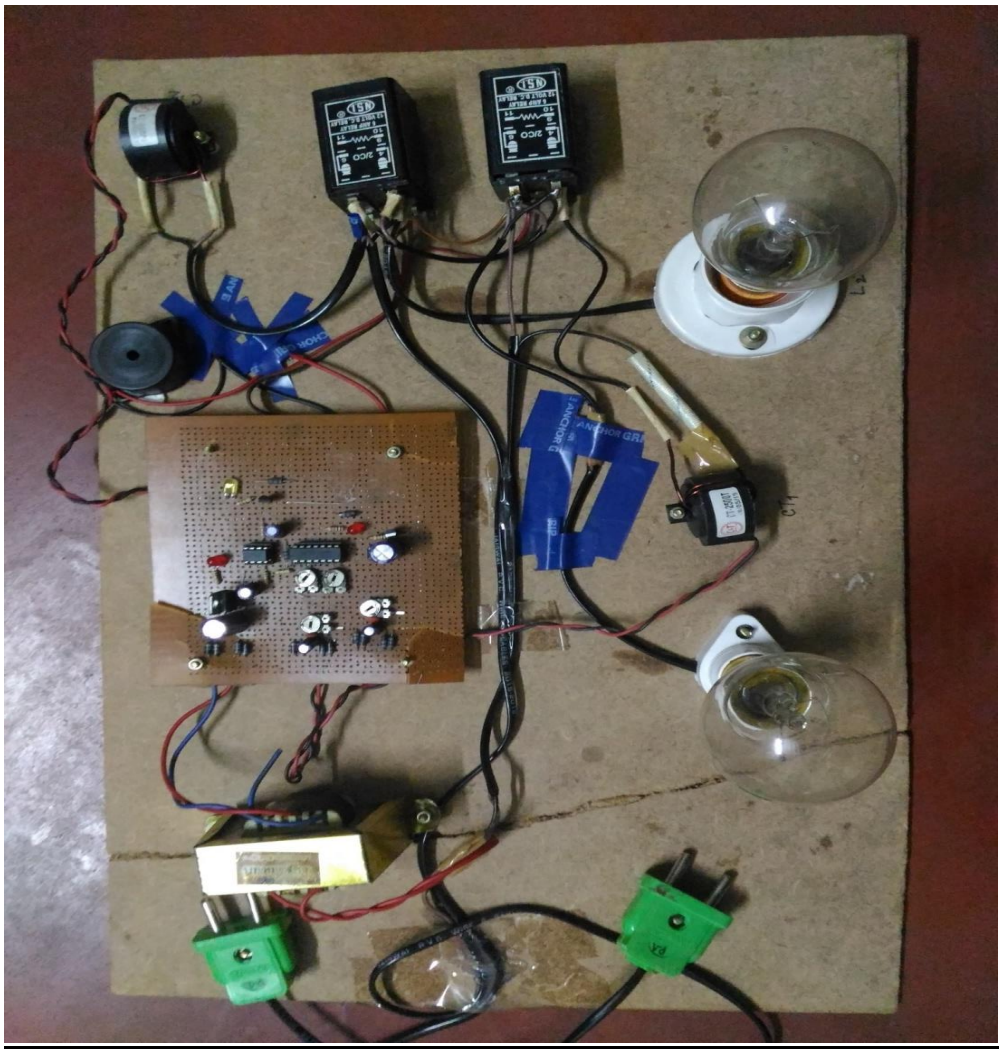
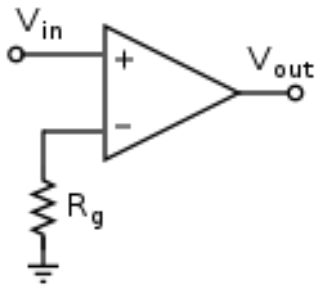


Fig 2: Phase shifter grid changeover relay when overload

2.3 Operation of Circuit 1

Instantaneous overcurrent relay for circuit protection:

LM324 :-This works as a comparator as an open-loop amplifier with pin 1,2,5,10,12 shorted together, pin 4 is v_{cc},pin 3 as input signal, pin 6,9,13 as R_g,pin 7 as output to LED indicator and pin 14 as signal to 555 timer pin 6(THRES),pin 11 as GND.



Op-amp as a comparator

Equation: $V_{out}=A_{OL}(V_+-V_-)$, where A_{OL} is Open-loop gain amplifier

555 timer: This works as a Schmitt trigger. It removes any noise signal in input and it generates square wave output signal. The output frequency is input frequency divide by 2.Pin 6 as input signal from pin 14 of LM324, pin 8 as $v_{cc,}$ pin 1 as GND, pin 2 as trigger using a push button switch to connect, pin 3 gives the final output to BJT.

Circuit: Here Core type transformer is connect to phase, the voltage is stepped down and AC is rectified to DC, this rectified voltage use capacitor filter to reduce ripples, which 12VDC is supplied as power to relay, this 12VDC further reduced to 5VDC and supplied to v_{cc} of LM324 and 555 timer.

When the reset switch is pressed it trigger the 555 timer and a signal is send from it's pin 3 to BJT, if $V_c<V_b<V_e$ that is if the circuit is overloaded then the relay trip thus protecting the circuit from burning.

Toggle switches are used to add loads.

2.4 Operation of Circuit 2

Phase Shifter grid changeover relay when overload:

LM324 :-This works as a comparator as an open-loop amplifier with pin 4 as v_{cc}, pin 1 as output to 555 timer pin 2, pin 2 as input from reference voltage, pin 5 as reference and PIN 3 as input voltage and pin 6 as input voltage, pin 7 as out to transistor.

555 timer: This works as a pulse sequencer at monostablemultivibrator. The pulse width may be equal width or unequal width, but they must come one after the other,it is used to generate a series of pulses in time sequence. Pin 2 as input from LM324, Pin 3 as output to BJT

2.5 Circuit:

When Load 2 is connected

a) Only Phase 1 is connected, thus due to absence of Phase 2, the Load 2 trip and does not continue to work due to lack of supply.

b) Both Phase 1 and Phase 2 are connected, the Phase 1 gets disconnected/trip and Load 2 is run by Phase 2 supply.

When Load 1and Load 2 is connected

a) Only Phase 1 is connected so when it trips it disconnects both Load 1 and Load 2 and due to missing Phase 2, Load 2 cannot shift phase, thus will not work due to lack of supply.

b) Both Phase 1 and Phase 2 are connected Load 1 gets tripped and disconnect with every pulse from 555 timer due to overload and Load 2 will continue to run on Phase 2

III. TECHNICAL SPECIFICATION

S. No	Name of apparatus	Specification
1	Relay	7A,250V,10A,12VDC/125VAC
2	Transformer(Core Type)	12-0-12, 1A
3	Current Transformer	50Hz,P: S= 1:5
4	Buzzer	3V to 27V
5	Voltage Regulator	7809,7805
6	Diode	IN-4007
7	BJT	--
8	Switch	Toggle,Push Button
9	LED	1.8V to 3V
10	Capacitor	(1K,330,110,33)uF
11	Resistor	(4.7K,10K,1K)
12	555 timer	v_{cc-} 5V
13	IC-LM324	v_{cc-}5v

IV. CONCLUSION

The designed and implemented is a low cost solution to overload and burning of circuit, it has been designed kept in mind of its application in conjuction with other projects as it is compact and economic in nature. We have successfully implemented the design and it is working and can actively play it's role as a protection circuit. The automatic phase shifting plays an important role of uninterrupted power supply even after continuous faults occurrence.Our Idea is supported by a fully working hard ware circuit.

Future Scope

This project was built keeping in mind of its future application and improvement in conjunction with other projects. It's is compact and economical thus providing a fault solution for Hospitals, Digital Resident Household, Office, Supermarket, Electrical appliances, white goods, automobile devices, O.A euipments, Industrial Application, Linking Information etc

With a higher budget microcontroller can be added with this circuit to provide a better application and automation through wireless signals.

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