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Automated Load Distribution with Password Protected Circuit Breakers

Narendra Khandelwal, Tanuj Manglani, Ganpat Singh, Amit Kumar, Dilip Khatri
Department of Electrical Engineering, YIT, Jaipur, Rajasthan, India
E-mail:narendra.p.khandelwal093@gmail.com

Abstract-The major problem in the power system is the load sharing. In this paper, an automated load distribution system has been proposed in which sharing of the load is done automatically between industrial load and rural load. Also, a password protected circuit breaker system is used to achieve more safety for a lineman during fault condition or maintenance period.

Keywords- Load sharing automated load sharing, circuit breaker, industrial load.

I. INTRODUCTION

The demand for electrical energy is ever increasing. Today over 21% (theft apart!!) of the total electrical energy generated in India is lost in transmission (4-6%) and distribution (15-18%). The electrical power deficit in the country is currently about 18%. Electric power is normally generated at 11-25kV in a power station. To transmit over long distances, it is then stepped-up to 400kV, 220kV or 132kV as necessary. Power is carried through a transmission network of high voltage lines. Usually, these lines run into hundreds of kilometers and deliver the power into a common power pool called the grid. The grid is connected to load centers (cities) through a sub-transmission network of normally 33kV (or sometimes 66kV) lines. These lines terminate into a 33kV (or 66kV) substation, where the voltage is stepped-down to 11kV for power distribution to load points through a distribution network of lines at 11kV and lower. The power network, which generally concerns the common man, is the distribution network of 11kV lines or feeders downstream of the 33kV substation. Each 11kV feeder which emanates from the 33kV substation branches further into several subsidiary 11kV feeders to carry power close to the load points (localities, industrial areas, villages).At these load points, a transformer further reduces the voltage from 11kV to 415V to provide the last-mile connection through 415V feeders (also called as Low Tension (LT) feeders) to individual customers, either at 240V (as single-phase supply) or at 415V (as three-phase supply). A feeder could be either an overhead line or an underground cable. In urban areas, owing to the density of customers, the length of an 11kV feeder is generally up to 3 km. On the other hand, in rural areas, the feeder length is much larger (up to 20 km). A 415V feeder should normally be restricted to about 0.5-1.0 km. unduly long feeder lead to low voltage at the consumer end.

Bottlenecks in Ensuring Reliable Power

Lack of information at the base station (33kV sub-station) on the loading and health status of the 11kV/415V transformer and associated feeders is one primary cause of inefficient power distribution. Due to absence of monitoring, overloading occurs, which results in low voltage at the customer end and increases the risk of frequent breakdowns of transformers and feeders. In fact, the transformer breakdown rate in India is as high as around 20%, in contrast to less than 2% in some advanced countries.In the absence of switches at different points in the distribution network, it is not possible to isolate certain loads for load shedding as and when required. The only option available in the present distribution network is the circuit breaker (one each for every main 11kV feeder) at the 33kV substation.

However, these circuit breakers are actually provided as a means of protection to completely isolate the downstream network in the event of a fault (short circuit, over load). Using this as a tool for load management is not desirable, as it disconnects the power supply to a very large segment of consumers. Clearly, there is a need to put in place a system that can achieve a finer resolution in load distribution. In the event of overloading of any section the circuit breakers trip, as a result, there is a blackout over a large section of the distribution network. If the load is increases in prior section then the supply in other section is disconnected that is there is no overloading on the feeder and power supply is continue in the prior section.

And this project is also designed to control a circuit breaker with help of a password only. A keypad is connected to the project to enter the password. Fatal electrical accidents to the line man are increasing during the electric line repair due to the lack of communication and co-ordination between the maintenance staff and the electric substation staff.

This proposed system provides a solution, which can ensure the safety of the maintenance staff e.g. line man. The control to turn ON/OFF the line lies with the line man only. This system has an arrangement such that a password is required to operate the circuit breaker (ON/OFF). Line man can turn off the supply and comfortably repair it, and return to the substation, then turn on the line by entering the correct password.

II. PROBLEM FORMULATION

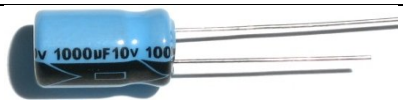
In the absence of switches at different points in the distribution network, it is not possible to isolate certain loads when required. However, the circuit breakers are actually provided as a means of protection to completely isolate the downstream network in the event of a fault (short circuit, over load). Using this as a tool for load management is not desirable, as it disconnects the power supply to a very large segment of consumers and blackout over a large section of the distribution network. As we found that if the power in industries is disconnect for a minute is stops the production. So the power in industries should be continues.

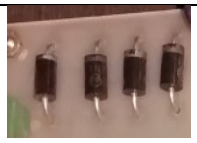
And when a line man goes to repair the line then by unknowingly or wrong intentionally any one can ON the circuit breaker and line man can be met with fatal accident.

III. COMPONENTS USED IN PROPOSED PROJECT

Various components like energy meter, relay, capacitor, crystal oscillator, voltage regulator IC, transformer, LCD, resistors etc. have been used in the present work which are described in table I.

TABLE I
LIST OF COMPONENTS

S. No.	Name of Component	Rating	Qty.	Purpose	Ref.	Photograph
1.	Energy meter	5-20amp, 240V, 50Hz	2	Measure energy consumption	[1]	
2.	Relay	10amp, 24V DC	3	ON/OFF Ckt	[2]	
3.	Capacitor	1000µF 10µF	5 2	Purify the dc Reset µC	[3]	
4.	Microcontroller 8051		2	Programming	[4]	
5.	Cristal Oscillator	3.5 MHz	2	Provide frequency to microcontroller	[5]	
6.	Voltage Regulator IC 7809	9V	6	Constant voltage	[6]	
7.	Transformers	9-0-9 Volts, 500 µAmp	5	Power supply	[7]	
8.	LCD Display		1	Display password	[8]	
9.	Resistors	10kΩ 5%	20	Voltage drop	[9]	
10.	Hexadecimal keypad		1	Input password	[10]	
11.	LED	2V	14	Indication	[11]	

12.	Bulb	100W, 220V	4	As Load		
13.	Diode		20	Rectifier	[12]	

A) Energy meter

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour [*kWh*]. Periodic readings of electricity meters establish billing cycles and energy used during a cycle.

In settings when energy savings during certain periods are desired, meters may measure demand, the maximum use of power in some interval. "Time of day" metering allows electric rates to be changed during a day, to record usage during peak high-cost periods and off-peak, lower-cost, periods. Also, in some areas meters have relays for demand response load shedding during peak load periods.

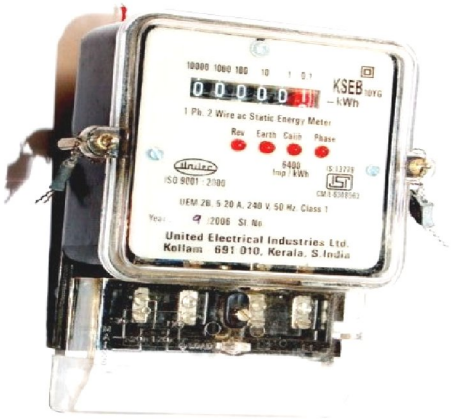


Fig.1. Energy Meter

B) Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays"

Fig.2. Relay

C) Capacitor

A capacitor is an electrical device that can store energy in the electric field between a pair of closely-spaced conductors (called 'plates'). When voltage is applied to the capacitor, electric charges of equal magnitude, but opposite polarity, build up on each plate.

Capacitors are used in electrical circuits as energy-storage devices. They can also be used to differentiate between high-frequency and low-frequency signals and this makes them useful in electronic filters.

Capacitors are occasionally referred to as condensers. This is now considered an antiquated term electrolytic capacitor. An electrolytic capacitor is a type of capacitor typically with a larger capacitance per unit volume than other types, making them valuable in relatively high-current and low-frequency electrical circuits. This is especially the case in power-supply filters, where they store charge needed to moderate output voltage and current fluctuations, in rectifier output, and especially in the absence of rechargeable batteries that can provide similar low-frequency current capacity. They are also widely used as coupling capacitors in circuits where AC should be conducted but DC should not; the large value of the capacitance allows them to pass very low frequencies.

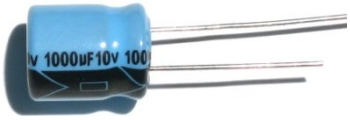


Fig.3. Capacitor

D) Microcontroller

Microcontroller is small computer on a single integrated circuit containing a prosser core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Fig.4. Microcontroller 8051

Intel 8051 is CISC architecture which is easy to program in assembly language and also has a good support for High level languages. The memory of the microcontroller can be extended up to 64k. This microcontroller is one of the easiest microcontrollers to learn. The 8051 microcontroller is in the field for more than 20 years. The best thing done by Intel is to give the designs of the 8051 microcontroller to everyone. So it is not the fact that Intel is the only manufacture for the 8051.

The architecture of the 8051 is given below.

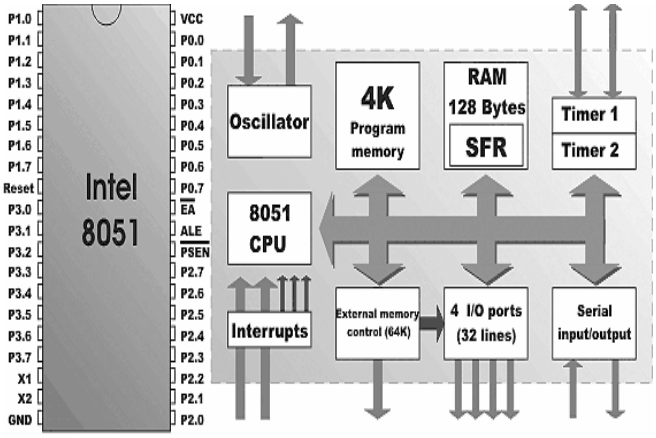


Fig.5. Architecture of Microcontroller

E) Crystal oscillator

Crystal oscillator is an electronic oscillator circuit that uses mechanical resonance of a vibrating crystal of

piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillator.

Fig.6. Crystal Oscillator

F) Voltage Regulating IC

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may use an electromechanical mechanism, or electronic components. Depending on design, it may be used to regulate one or more voltages.
7809 voltage regulating IC is used to provide the voltage 9V dc.

Fig.7. Voltage Regulating IC

G) Transformer

A transformer is electrical device that transfers the energy between two circuits through electromagnetic induction. A transformer may be used as a safe and efficient voltage converter to change the ac voltage at its input to a higher or lower voltage at its output. Other uses include current conversion, isolation with or without changing voltage and impedance conversion. It can also change the voltage level (lower to higher) and wise versa. Here in this project we are using it to step down the voltage level.

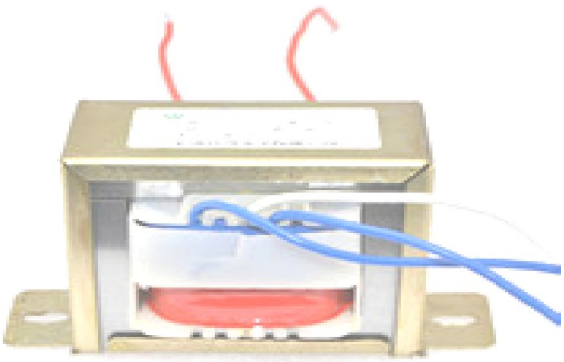


Fig.8. Transformer

H) LCD Display

The term liquid crystal is used to describe a substance in a state between liquid and solid but which exhibits the properties of both. Molecules in liquid crystals tend to arrange themselves until they all point in the same specific direction. This arrangement of molecules enables the medium to flow as a liquid. Depending on the temperature and particular nature of a substance, liquid crystals can exist in one of several distinct phases. Liquid crystals in a nematic phase, in which there is no spatial ordering of the molecules, for example, are used in LCD technology. Here this used to display the password entered by us to ON/OFF the circuit breakers.

Fig.9. LCD Display

I) Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. Resistors may have fixed resistances or variable

resistances, such as those found in thermistors, varistors, trimmers, photoresistors and potentiometers.

The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$$I = \frac{V}{R}$$

where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms (symbol: Ω).

The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

Fig.10. Resistor

Fig.11. Variable Resistor

J) Hexadecimal Keypad

HEX keypad is a standard device with 16 keys connected in a 4x4 matrix, giving the characters 0-9 and A-F. Interfacing of Hex key pad to 8051 is very essential while designing embedded system projects which requires character or numeric input or both. For example projects like digital code lock, numeric calculator etc. Here we are using this to enter numeric password for turn ON/OFF the circuit breaker.

Fig.12. Hexadecimal Keypad

K) LED

A LED is two lead semiconductor light source that resembles a basic pn junction diode, except that an LED also emits light. When an LED's anode lead has a voltage that is more positive than its cathode lead by at least the LED's forward voltage drop, current flows. Electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of light is determined by the energy band gap of the semiconductor. In our project LEDs are used for power indications.

Fig.13. LED

IV. WORKING OF THE PROJECT

The project is automated load distribution with password protected circuit breakers. In this the power is automatically distributed over two sections. First one is village feeder and second one is industrial feeder. We used three relays first one for industrial feeder, second one for village feeder and third one for password protection of village feeder which is connected in series with village feeder relay. As we want to supply continue power to the industries, i.e. if the load demand is increases in industrial feeder than to continue the power in industrial feeder, the supply of village feeder to be

disconnected that means the relay of village feeder to be operated.

`For this purpose we take output from the energy meter of the both of feeders and compare them by comparator IC. The sum of both energy meters reading is send by comparator IC to Microcontroller. If the sum of readings more than the prescribed value then signal is send from microcontroller to relay operating IC which cutoff the supply in village feeder by trip the village feeder relay. The circuit diagram for this working is shown in fig.14.

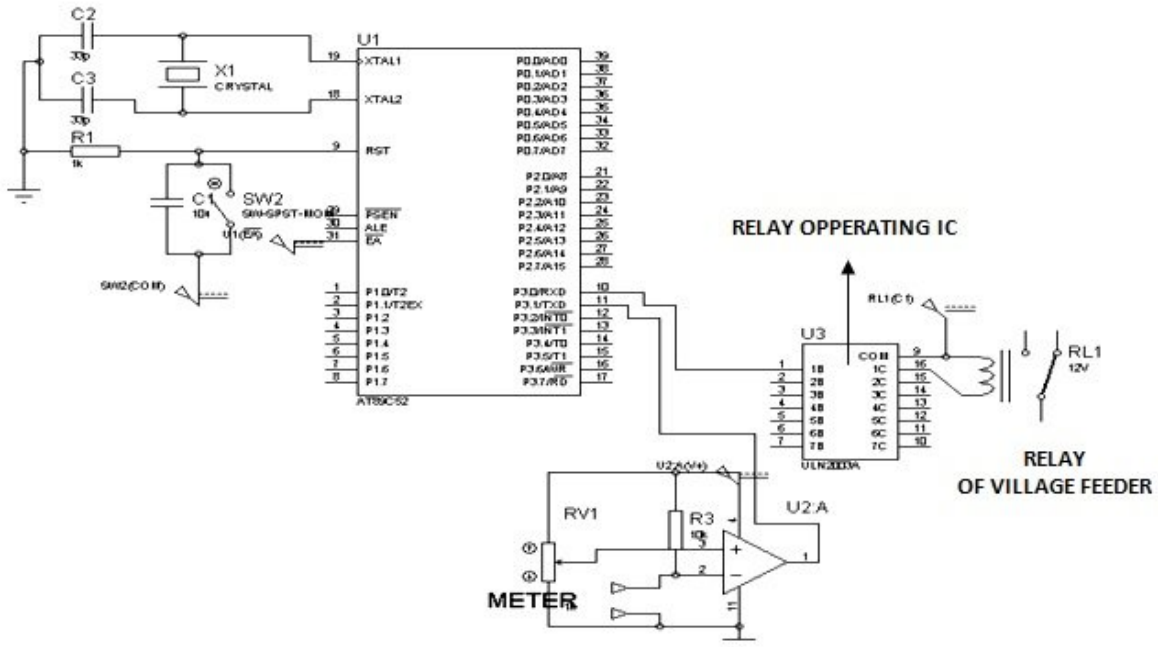


Fig.14. Circuit Diagram for Automated Load Distribution

Let we required maintenance in village feeder, if the industrial load is heavy then the village load relay is automatically off. In this situation if maintainer goes for the maintenance of line and suddenly industrial load become low it means by default the village feeder relay will operate automatically and maintainer may met with fatal accident.So, for protection of maintainer we use third relay which is connected in series with village feeder relay. This relay is operated by password. This is done with the help of microcontroller. First of all the password is preset by programming. When we entered the password by the hexadecimal keypad if it is matched by preset password then the microcontroller sends a signal to trip the password based relay. And again when maintenance is done, password to be enter and if it matched with preset password, signal is send by microcontroller and relay ON.

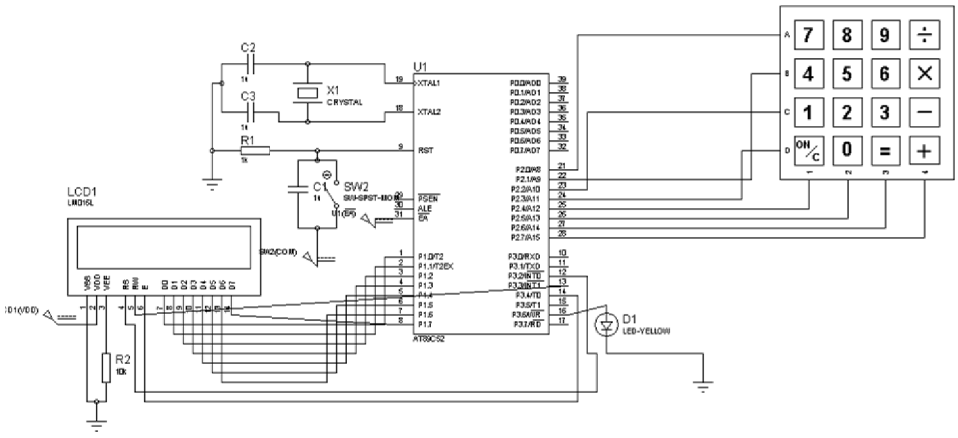


Fig.15. Circuit Diagram for Password Based Circuit Breaker

V. TEST RESULT

Light industrial load

When industrial load is less than the prescribed value then one village load can be operated.

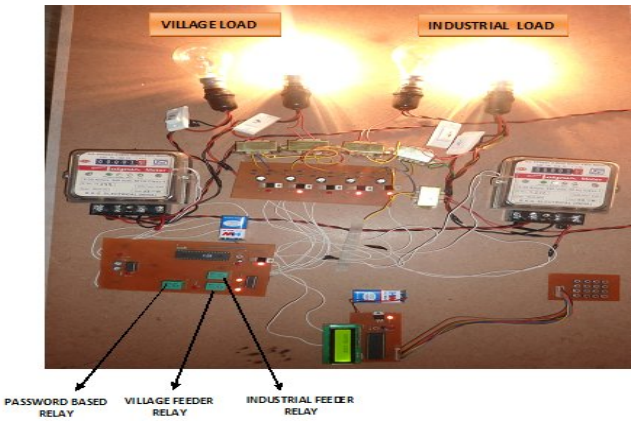


Fig.16. Heavy Industrial Load

Heavy industrial load

During heavy industrial load, supply of village feeder is cutoff.

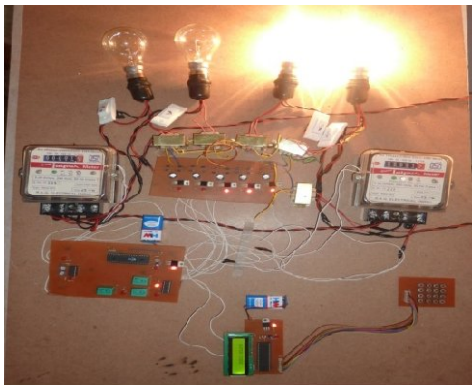


Fig.17. Heavy Industrial Load

When village feeder to be off for maintenance

For maintenance purpose the supply of village feeder to be cutoff. It can be done by entering the right password and again ON by entering the right password.

Fig.18. Power Cut by Password

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