International Journal of Research in Engineering, Science and Management
Volume-2, Issue-12, December-2019
www.ijresm.com | ISSN (Online): 2581-5792

Demand Side Management for Motoring and Lighting Loads

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***Abstract*: The project helps in reducing the power demand by shedding off the unwanted loads thereby giving a warning to the companies that the maximum demand is going to be reached. The companies though are making use of Maximum Demand Controller, the project is a novel load management for industries by controlling the power thereby reducing the penalty and the power which is the great issue.**

***Keywords*: Demand Side Management, PIC16F877A, load shedding, loads.**

1. Introduction

In houses, the electricity bill is in terms of KWh, but in industries there are three terms that appear in majority of electricity bills

1. Active energy consumption
2. Reactive energy consumption
3. Maximum Demand

Two items are focused,

1. Reduction of Kilowatt Hour consumption
2. Improving the electrical system's Power Factor

There is a third item to consider when reducing the amount of the electric company bill, proper kW Demand management which allows [1]

1. The reduction of the contracted power
2. Adjusting to the new kW limit
3. Avoiding kW Demand limit penalties

Priority is being followed in loads which help in shedding off the lighting and other loads like air conditioner. However it is not easy to choose a specific DLC strategy or program in predicting the effectiveness of a strategy and it is somewhat complicated because of the load dynamic responses during the load control durations and diverse objective to be considered [3], [4].The maximum demand controller is being followed in industries now a days. This control gives a buzzer sound whenever maximum demand is reached. It is manually operated. After the buzzer sound all the loads need to be cut off. After 15 minutes with the help of any other source the wanted loads or the criticalloads can be turned on again. Now on from February month the EB has reduced the demand to 60% of the total maximum demand. For example let us consider an industry has started since 2009 and is demanding around 1000 KVA .The company is undergone to check three times whether it has crossed the maximum demand or not and 60% of the rating that is 600 KVA is fixed for those companies in upcoming days as a punishment for crossing the maximum demand. By this way the power consumption is being reduced by industries. But then the industries can go to the private sector to demand more power which is also an inefficient way as the transmission charge called as wheeling charges has to be paid to the EB. Thus the reduction of power and penalty is the main target. Air conditioning units that can be controlled remotely and the customers purchasing such units receive subsidies from the power company have also been in the market [1]. The power company turns off the air conditioners through network for about 10 to 15 minutes each time to shed the loads, however it is inconvenient to both the customers and power company, as the customer does not know when the air conditioner is going to be turned off, and moreover for the power company also controlling hundreds of small air conditioner loads is neither effective nor efficient [1]

2. Demand side management for loads

A. The viable option

Demand Side Management (DSM) is now becoming a viable option for deferring or replacing the constructions of power plants and transmission and distribution (T&D) facilities in many countries. Shaving the peak loads with DSM facilitates maintaining the power system spinning reserves as well as the capacity reserves at safe levels during heavy load periods without additional unit commitments. In addition to this benefit, if direct load control (DLC) with interruptible load management (ILM) can be performed in real time as a measure of implementing DSM, overall power system operational stability can be greatly enhanced since the power system operators can now exert load shedding as an effective emergency control measure. As such, utility companies or other power system operating entities, bearing different names depending on each deregulated structure, normally offer various incentives in the form of rate benefits and direct compensation for customers participating in the utility's DLC programs. Among various ways of implementing the DSM, the DLC with the ILM is the most effective measure giving the power system operators the instantaneous reserves that are equivalent with real-time generation and transmission capacity increases [1]. However, it is not easy to choose a specific DLC strategy or program since predicting the effectiveness of a strategy is somewhat complicated because of the load dynamic responses during load control durations and the diverse objectives to be considered [2], [3]. Moreover, some of those factors are even subjective in nature. A technique for classifying the DLC curves by selecting significant features with self-organizing maps to check whether they comply with the established models has been proposed [4Jorge et al. address the multi-objective nature of the DSM and propose a multiple objective decision support model considering major concerns in load management such as minimizing peak demand, and maximizing utility and customer benefits [3].As such, many researchers have proposed load management strategies concerned with shaving peak demands or providing reserves while others focused on minimizing utility operational costs, maximizing utility profits, and lowering customer utility bills. Since the main reasons for installing the air conditioners and water heaters are for convenience such that the customers turn on or off them whenever they want to, putting any form of restriction on the usage of these loads directly conflicts with the objectives of such installations.

B. Penalty calculation

Over consumption of power leads to penalty.
Contracted power =136 KW
KW demand meter reading =253 KW
Maximum demand without surcharge:
136KW*1.05 =142.80KW
Excess power consumed =253-142.80=110.2KW
KW penalty: 110.2KW*2 =220.4KW
Total KW to be billed:
220.4KW+253KW =473.4KW

Thus penalty is calculated for 473.4KW of power which is the biggest problem for industries which can be resolved by means of this project.

3. Hardware implementation

A. Block diagram

Both the critical and non-critical loads are supplied with one source only say source 1. We are setting the priority depending on the requirements. The power supply unit is supplying the motoring and lighting loads. The current is measured using the suitable current transformer and it gives respective voltage according to current value which is given to the microcontroller as the supply voltage. The microcontroller is capable of bearing only 5V; it is the maximum supply voltage of the microcontroller. A buzzer is being connected which is used as a signal to avoid the penalty problems which is due to maximum demand. Before reaching the maximum demand itself the buzzer is turned on thereby alerting the operators that the maximum demand is going to be reached. The operator need not turn off the loads separately which is an additional advantage of our project. Then non critical loads are turned off automatically. Let us assume that a company is given only 100KW of power. Let 80KW of power be the maximum demand. Before reaching 80KW of power it the non critical loads such as,

- Lights
- Compressors
- Air conditioners
- Pumps
- Fans and extractors
- Packaging machinery
- Others../are turned off automatically. Thus the remaining 20KW of power is supplying the critical load thereby ensuring continuity in service.

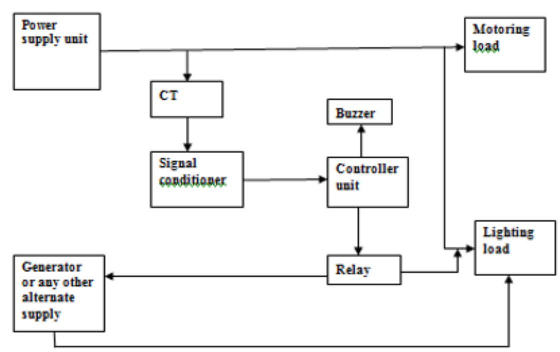

Fig. 1. Block diagram

This shedding is made possible by the microcontroller. Then non critical loads can be turned on again be making use of any other source like generators if necessary. The operation of non-critical loads varies from industries to industries. In some industries they contribute to maximum of power supply and in some other industries it contributes only less. Thus apart from contribution saving is the main criteria which has to be considered.

B. Circuit diagram

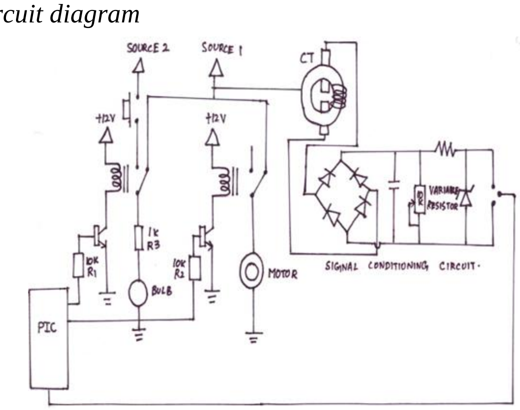

Fig. 2. Circuit diagram

There are two sources available called source 1 and source 2. From source 1 the 230V AC is given to the step down transformer thereby reducing the voltage to 12V AC. This voltage is again given to the power supply unit. The power supply unit consists of bridge rectifier, capacitor and voltage regulators. The 12V AC is converted into 12V DC with the help of bridge rectifier. The diodes which we use in bridge rectifier is IN4007.The ripples are removed with the help of capacitor. The 7812 voltage regulator is being used and the 12V is given to the relay. The 12V is required for energizing the relay. The 12V from 7812 voltage regulator is converted into 5V with the help of 7805 voltage regulator. The requirement of 7805 is that the micro controller which is being used can tolerate only 5V of power supply. The 7805 voltage regulator helps in reducing the 12V to 5V. The current transformer senses the current and it converts the respective current into its respective voltage which is given to the signal conditioning unit. The signal conditioning circuit consists of a bridge rectifier, capacitor, variable pot and then the zener diode. The bridge rectifier converts AC to DC. From bridge rectifier it is given to the capacitor which removes the ripples and then to the variable resistor. From the variable pot it is given to the zener diode which maintains the saturation voltage as 5V. The relay consists of a coil, one end of which is connected to 12V and other end of the coil is connected to the collector of the transistor TIP122.The emitter of it is being grounded and the base is connected to the micro controller through a 10k resistor. To the pin33 of micro controller the base of the transistor TIP122 is being connected. There are three phases and three neutral seen in the relay. To one phase and neutral the source1 is connected, to the second phase and neutral the source 2 is being connected and to the third phase and neutral the load is being connected. There are two loads seen in the circuit diagram one is the lamp load and the other is the dc motor. We assume the lamp load to be the non-critical load and the dc motor to be the critical load. Our aim is to run the critical load. The non-critical load like the lamp load can be turned on again with the help of another source like source2 if required. The dc motor requires 12V which demands the requirement of power supply unit. Though our project helps in saving power and money the requirement of additional source like generator will lead to an additional cost. Apart from initial cost the maintenance cost is also an issue which has to taken into consideration which is an additional disadvantage.

4. Simulation details

Algorithm

- Step 1: Start the process
- Step 2: Set the maximum demand value which will vary depending upon the company.
- Step 3: A condition is checked whether the demand is greater than the maximum demand or not.

a) If no: Both the critical and non-critical loads operation is in progress.
b) If yes: The non critical loads are turned off and only the critical loads are made to run.
c) The alternate supply like generator can be made use of to turn on the non critical loads.
d) The non critical loads are thus made to run with the help of an additional source like generator and the critical loads are in progress by means of main power supply unit.

Step 4: Thus the company saves both the money and the power.

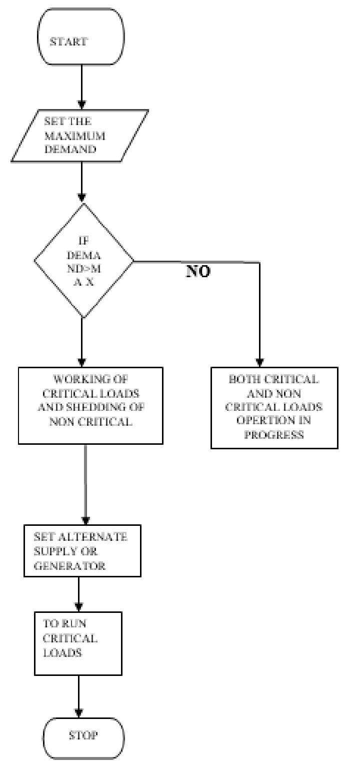

Fig. 3. Flowchart

A. *Simulation result*

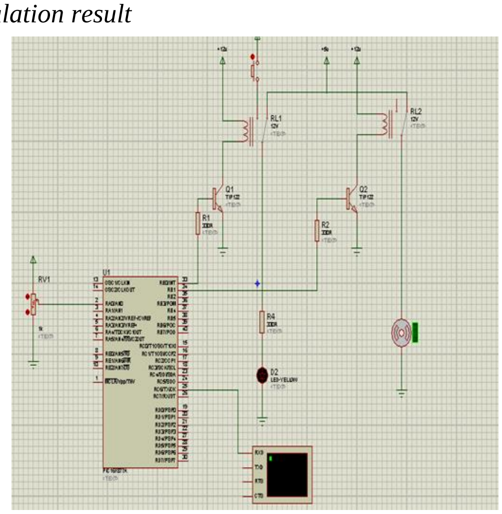

Fig. 4. Simulation

In the circuit diagram a micro controller is being used. A variable resistor is being connected to pin no 2. The other end of variable resistor is grounded. To pin no 33 relay 1 is connected to pin no 34 relay 2 is connected. A 12 v supply cannot be connected to microcontroller directly as only 5v is the maximum supply voltage of the Microcontroller, so we connect a transistor in between a supply voltage source and microcontroller. In this circuit diagram we assume two loads as critical and non-critical. The critical load is essential load. The non critical load is the non-essential load. Let us assume that the critical load to be the led and non-critical load to be dc motor. A serial communication interface is connected to the pin no25.To avoid the damage of instruments we connect resistor for transistors, led and dc motor. Initially we have assumed that the 5V is the maximum supply voltage. Whenever the supply of 1V is set both the critical and non-critical load is running. Whenever the supply of 2Vis increased the non critical is turned off and only critical load is running. Thus we have successfully proved that the non-critical loads can shedded off whenever the maximum demand is reached.

5. Hardware result

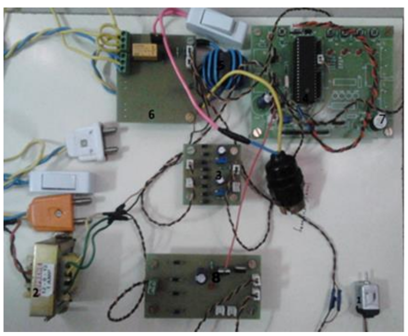

Fig. 5. Hardware

- Dc motor
- Step down transformer
- Signal Conditioning circuit
- Micro controller
- Current transformer
- Relay
- Buzzer
- Power supply unit

Input:

- 40W and dc motor
- 60W and dc motor

Output:

Normal demand: Both the critical and non-critical load will run.
Demand near to maximum demand: Only the critical load will run.

6. Conclusion

Thus by means of this project we have proved that maximum demand can be brought in to control thereby reducing the penalty and power. The non critical loads are shedded off before the maximum demand is reached automatically giving a signal to the industry that the demand is going to be reached. In case of requirement the non critical loads can be turned on again with the help of any other sources like generators. Thus this technique is an advantage when compared with the Maximum Demand Controller (MDC).

Merits:

1. Reduction of money.
2. Reduction of power consumption.
3. No interruption in continuity of supply.

Demerits:

1. Requirement of an additional supply like generator leads to an additional cost.
2. Maintenance of generator is also an issue.

7. Future enhancement

We have proved through our project with 230V the shedding of non-critical loads. A 40W bulb and a dc motor are connected as the initial loads. Both the loads get operated as they didn't reach the maximum demand. To prove the concept of shedding and maximum demand we assume a 60W bulb and dc motor again. Now the bulb gets turned off and only the critical load which is the dc motor is running thus proving the concept of shedding. In industries likewise we have non critical loads like

- Lights
- Compressors
- Air conditioners
- Pumps
- Fans and extractors
- Packaging machinery
- Others...

These loads can be shedded off with an alarm signal. Thus the maximum demand problem can be resolved.

Thus

1. The reduction of the contracted power
2. Avoiding kW Demand limit penalties has been made possible.

When companies perform this sort of shedding they not only save money but also power which is great demand now a days. By saving the power we prevent the additional unit commitments and also the construction of new power plants.

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