International Journal of Electrical and Electronics Engineering (IJEEE)
ISSN(P): 2278-9944; ISSN(E): 2278-9952
Vol. 6, Issue 5, Aug - Sep 2017, 1-14

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

IMITATION & DEPICTION POWER FACTOR EMENDATION DEVICE FOR MINIMIZATION OF PENALTY IN POWER SYSTEM

SHARAD CHANDRA RAJPOOT[1] & PRASHANT SINGH RAJPOOT[2]

[1]Assistant Professor, Department of Electrical Engineering, G.E.C. Jagdalpur, Bastar, Chhattisgarh, India

[2]Assistant Professor, Department of Electrical Engineering, L.C.I.T., Bilaspur, Chhattisgarh, India

ABSTRACT

Today, we are familiar that, electricity is the most essential thing all around the world. Without electricity, we can't imagine the glorious future. Each and every machine depends on the electric power supply. In the absence of electricity, not only the machines would provides the proper performance, but also the human beings feels like they are moving & reached in the ancient life. If the electricity goes off, really everything has nothing worth. Power factor is playing very important role in efficient power supply. There are certain organizations that are developing products and caring R&D work in this field, to improve or compensate the power factor.

The non-functional is out of question. Recently, the technical revolution made embedded technology shape, so that it can be applied to all the fields.

KEYWORDS: AC/DC Power System, Power Factor, Power Factor Improvement, Stability Analysis, Power System Stability

INTRODUCTION

At yet stage, the automation becomes part of each and every article. Automation can be obtained through the programming techniques. Whenever we are thinking about any programmable devices, the embedded technology comes into the forefront. The embedded technology is mostly applied at yet time, in which, the automation can be achieved with the help of the microcontroller. [14]

Power factor is one of the essential parameters to improve the system reliability and stability. If the power factor will move toward the prescribe limits, then it will be responsible for extra charges [2]. If the power factor is within the desired boundary, then the reactive power requirement of the systems will mitigate and real power relinquishment will be further enhanced.

Power Factor

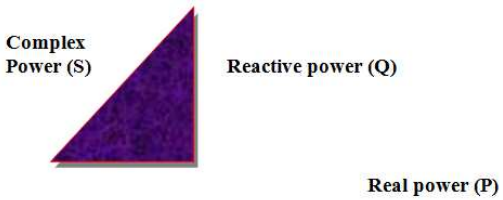

Figure 1: Power Triangle

Power factor is defined as a cosine angle between the supply voltage and the line current flowing into the circuit. It is the ratio of the real power & apparent power. Power factor lies within the range of 0 to 1.

REAL POWER = VICOSϕ

APPARENT POWER = VI

Power factor predominantly depends on the nature of the applied load on the given circuit. Ordinarily, it is lagging, because normally the load is inductive in the nature. The power factor is principally hinging on the nature of the load in any given circuit, which is elaborate in the Table no. 1

Table 1: Load V/S Power Factor

S. No.	Nature of the Load	Power Factor
1	Pure Inductive Load	Zero Lagging
2	Pure Capacitive Load	Zero Leadding
3	Pure Resistive Load	Unity
4	R-L Load	Lagging
5	R-C Load	Leading

Low-power-factor load increase losses in a power distribution system and results in increased energy costs [2]. So, it will be responsible for the indigent efficiency of the distribution system.

In a purely resistive AC circuit, voltage and current wave forms are in phase changing polarity, at the same Instant in each cycle. Whenever, the load is inductive or capacitive, and then it consumes part of power to store within it. This stand energy returns to the source, and is not available to do work at the load account. Hence, a low power factor will have higher current to transfer given quantity of real power than a circuit with a high power factor.

THE STUDY OBJECTIVES

General Object

The primary ambition is to mitigate the extra charges and payment by the consumers. It also supports in reduction of size, ratting and the cost of the instruments.

Specific Object

In light of the above objective, specific objectives of the study are as follows:

- To develop a prototype of an automatic power factor corrector, with microcontroller as the brain of the control system.
- To improve low power factor, improve energy consumption by industries, improve the stability and efficiency of the transmission network

THE RESEARCH PROBLEM

Electricity can be generated through a technique, and this generated A.C. Power is primarily boosted up, and then fed into the transmission line toward many numbers of the distribution substations. This electrical power will further step down as per the needs of the requirements and then feed into the divergent loads. Some of them are an industrial load, which is mostly effect the power distribution, performance and also the consequence of the power factor in the distribution

system. The power factor will influence the reliability, stability and adequacy of the distribution system. Poor power factor origininate extra charges to the consumers. In this way, it must be in desired limit for proper performance of the distribution system.

EXPECTED OUTCOME OF THE PROJECT AND POSSIBLE USAGE

Power factor is variation between 0 and 1. If the power factor crucifix the frontier, and then it causes many side effects. We pay the bill charges for active power consumption, if the power factor is within the prescribe limits, but if the part of that, then it will cease to extra charges as a penalty.

Another side effect of poor power factor is that, it's responsible for enhancing the extra insulation to limit the subsidiary current demand to full fill the peal power demand. So, the size and cost of the instruments come to be huge.

So, the power factor must be within the threshold position. The power factor can be boosted with the help of the synchronous phase modifier, shunt capacitor across the inductive load and phase advance.

SAFETY, ENVIRONMENT AND ECONOMIC

Aspects Safety

- The project, if undertaken and implemented, poses no known hazard to personnel or the network, on which, it is installed.
- It must however be installed, maintained and serviced by a qualified person to achieve optimum performance.

Economic

- The project if implemented shall cut cost for the service provider.
- The project when completed will make the electrical transmission system efficient and stable.
- It will reduce electricity costs by eliminating power factor surcharges.
- The project when completed will enhance equipment operation by improving voltage.
- The project when completed will reduce line losses.
- The project when completed will free up transformer and distribution system capacity.

Environmental

- The device components in the set up are not likely to pose any environmental problems, however the device/components ought to be kept free from obstruction free from dirt and fumes. And, free from touch by children, and maintained within a recommended design temperature.
- In case of the faulty device / component, disposal shall be done in an environmentally friendly manner.

Summary of Study Result

- Designing a good microcontroller based power factor correction device, to help improve power factor, reduces the high current drawn from the system and also reduce harmony in the system.

- Improving the efficiency of the system and reducing high electricity tariffs.
- It is applicable to a commercial single phase system.

POWER FACTOR AMELIORATION

Power factor of any circuit mainly depends on the load connected through it. The load on the distribution system changes time to time, sometimes it's low and another moment it becomes huge. At tiny load times, the supply voltage becomes high, this will supports to the huge, fascinating current through the circuit, which is responsible for the poor power. Power factor is principally of three types, as shown in Figure No. 2

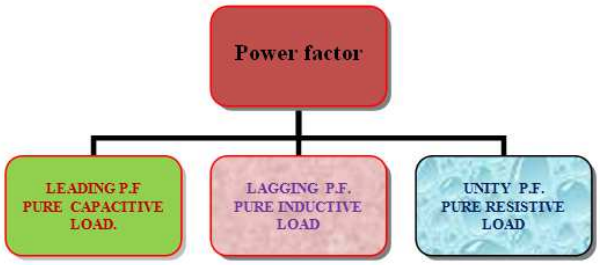

Figure 2: Types of the Power Factor

Power factor mostly varies according to variation in the phase angle between the supply voltage and current, which flows through the given circuit. Power factor is poor due to the following factors-

- Inductive load
- Induction motor
- arc lamps
- Transformers
- Heating calefactory
- Welding machine

In the case of the pure inductive load, the phase angle between the voltage and current becomes exactly 90*, so the power factor, which is the cosine angle between the supply voltage & line current becomes zero (Zero P.F. Lagging) as shown in Figure no. 3

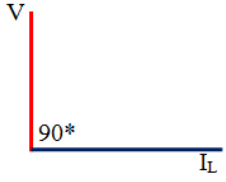

Figure 3: V-I Curve for Pure Inductive Load

In case of the pure resistor, P.F. will unify because, the phase angle ∞ will be zero between the voltage & line current.

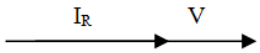

Figure 4: V-I Curve for Pure Resistive Load

The power factor can be emendating with the addition of a capacitor across the load. Capacitor injects leading current, which washout the effect of the lagging current, in this way, the power factor emendates.

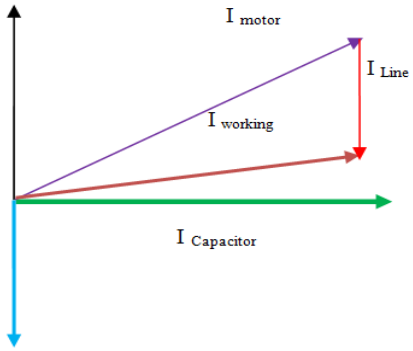

Figure 5: Phasor Dig. of P.F. Emendation

Static Rectification

In this technique, a capacitor is connected in parallel to the load. Most of the loads are inductive in the nature, which causes the worst power factor. The effect of the inductive load can be compensated with this connected capacitor across the inductive load, because it ejects the leading current which diminishes the lagging effect.

PRINCIPLE

The automatic power correction device is developed basing on a micro controller 89c51.The voltage and current sampled is converted into square wave using a zero cross detector. The V and I sampled signals are fed to the micro controller at INT0 and INT1, and the difference between the arrival of wave form indicates the phase angle difference. The difference is measured with high accuracy by using internal timer. The value is displayed in the 2x16LCD modules, after suitably the capacitor banks are switched as per the calibration in steps.

Methodology of Hardware

The aim to monitor the power factor continuously in the event of change in power, which usually results in the demand for higher current correction action, which is initialized to compensate for this difference continuously.

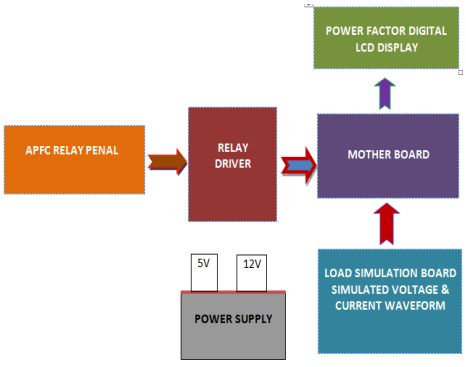

Figure 6: Block Diagram APFC

SPECIFICATIONS OF HARDWARE

Power supply

230V AC is given in input of the system. It is stepping down with the help of the step down transformer. Output of the transformer is 12V Ac, which further feed into the bridge rectifier circuit & then converts into DC quantity. Bridge rectifier, have four diodes in which, two operates in each bias situation. Bridge rectifier converts the AC into pulsating DC, but we need DC for the relay driver operation, so it passes through the filter circuit to convert into pure DC quantity. Filter circuit has a capacitor, which passes the Ac and block the DC through it. DC supply is further fed into the controller, which controls the operation of the whole system.

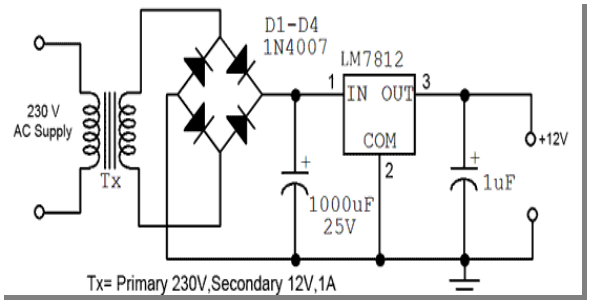

Figure 7: Power Supply System

Association between the A.C. & D.C. quantity-

$$V_{dc} = V_m/\pi \text{ (ago the capacitor use)} \quad (1)$$

$$V_{dc} = V_m \text{ (ahead the capacitor used)} \quad (2)$$

Table 2: Components & Their Ratting

S. No.	Component	Rating	No. of Component
1.	Resistance	100k	3
2.		560k	2
3.	Relay	5A	2
4.	Capacitor	10µF	2
5.		15 µF	1
6.	Transformer	220V-12V	3
7		220V-5V	2
8	Display		1

Zero Crossing Detectors

It is one of the convertors. It is that device, which limits the output waveform. If that boundary condition is the zero value, then it cuts out the extra part of the wave form to get the desired one in the output. In this way, it converts the sinusoidal waveform into the square one.

Motherboard

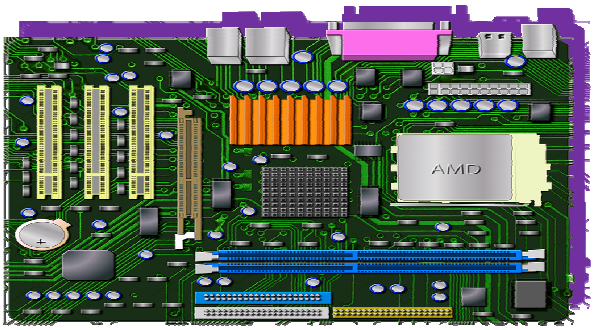

Figure 8: Mother Board [16]

The mother board is the principal part of the whole system. Without it, the system cannot work properly. It provides the location to install the storage devices, control unit &logical units and other input output devices. Different types of the cards are fixed on it, through soldering process

It is made through the semiconductor material. Especially, the silicon is used in manufacturing of it. It is one of the extended forms of the printed circuit board.

Resistance

Figure 9: Resistance Color Coding

Substances, in which, electricity can flow are called conductors. A piece of conducting material of a particular resistance, meant for the use in a circuit is called a resistor. Conductors are made of high-conductivity materials such as metals, in particular copper and aluminum.

Ohm's Law

Figure 10: Ohm's Law

Ohm's law explains what the relationship between supply voltage and circuit current is." The current flowing through any closed circuit is directly proportional to the voltage applied across it, only if the physical conditions just like temperature & pressure doesn't change."

Relay

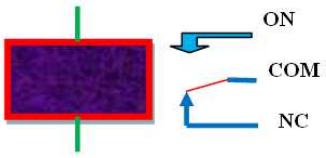

Figure 11: Circuit Symbol of Relay

It is an electromagnetic protective device. It senses the fault condition. If the fault is minor, then gives only the alarm signal, but if the fault is major, it generates the control signal to feed into the circuit breaker to disconnect the faulty section from healthy one. In this way, it supports to enhance the performance and reliability as well as the stability of the system.

Capacitor

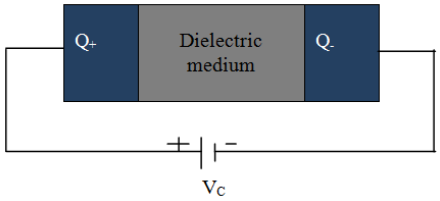

Figure 12: Parallel Plate Capacitor

It is one of the energy storage devices. It stores the energy in the form of the charges. A capacitor was therefore, historically, first known as an electric condenser. It forms with two conductors separated by a dielectric medium. Initially, it is passive element, but after charging, acts as an active element.

DC Circuit

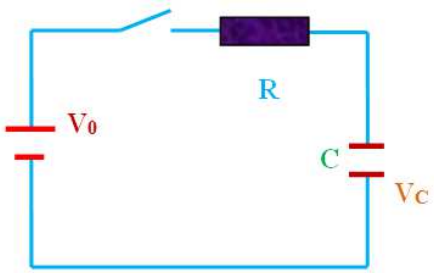

Figure 13: Dc Circuit

In D.C. circuit, the fixed charges flow through the closed path from giant to tiny dormant. A D.C. series circuit is sown in above figure, which consists of a resistor and a capacitor. Initially, the capacitor acts as short circuit, until fully charge to the supply voltages (V_0 = V_C). Then after, it acts as a source, and finally the circuit current mitigates, exponentially.

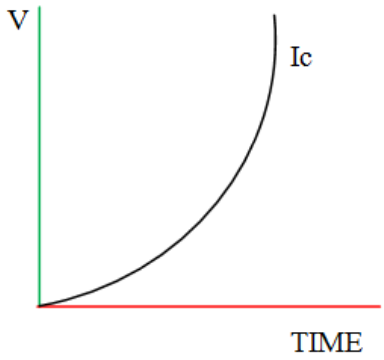

Figure 14: Characteristic of the D.C. Circuit

Voltage Regulator

Figure 15: Voltage Regulator

It converts the variable A.C.Voltage to desired D.C. voltage as per need of the particular circuit. It acts as a voltage stabilizer. It can self-execute to maintain the stable potential. In this way, it succors in, to acquire power supply.

Automatic Voltage Regulator (AVR)

It is one of the semiconductor devices, which is adopted to command the A.C, the potential obtained from the alternator. It is installed in neighbor to the alternator. It gives the automatic operation to regulate the voltage, so it is called an automatic voltage regulator. Its automation can be possible due to the microcontroller, embedded in its circuit.

Liquid Crystal Display (LCD)

LCD is a semiconductor device, which any circuit board will display the reading to be measurable. It is one of the optical devices.

Applications of the LCD

It is widely used in yet time. Used in:

- Digital camera
- Computer & TV monitors
- Digital watches
- Mobile display
- Energy meter
- Calculators, etc.

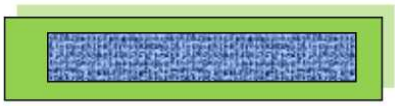

Figure 16: LCD

Transformer

The transformer is static, electromagnetic constant power device, which transfer the power one to another circuit, without changing the system frequency.

How Transformer Works

It works on the principle of the farads electromagnetic induction.

$$E = d\lambda / dt \quad (3)$$

$$\lambda = N \Phi \quad (4)$$

so from the equation 1 & 2 we gate

$$E = -N (d \Phi / dt) \quad (5)$$

Sign represents the Lenz law (causes oppose the action).

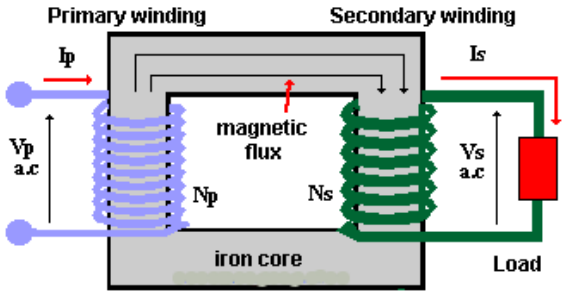

Figure 17: Working Principle of Transformer [16]

Isolation

The transformer is an energy transfer device, in which, the circuits are electrically isolated and magnetically coupled. The resistance between the primary and secondary winding is infinity. Its turn ratio is 1:1.

Impedence Matching

Impedance matching is one of the important factors to reap the maximum power transfer towards the load centre. For impedance matching, the load resistance must be equal to the equivalent resistance of the given circuit.

$$R_L = L_{TH} \quad (6)$$

Where t R_L = load resistance

L_{TH} = circuit equivalent resistance

Clock Generator Oscillator

It is one of the circuits, which generates the slate pulse. This slate pulses helps to synchronize the operating circuit. Principally, this pulses are in the form of the square wave.

It is a series resonance circuit. Its essential parts are shown in Figure no. 18

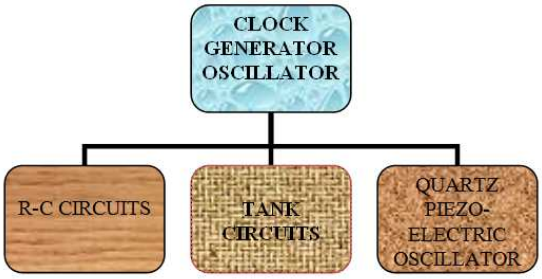

Figure 18: Essential Parts of the Clock Generator Oscillator

Quartz Resonator

It supports the well built number of cycles per second of the quartz crystal. It is used in the oscillator. If force or pressure is applied to it, then they produce the voltage in proportionate amount.

If we connect two capacitors of particular values, then they will be responsible for a particular frequency, as shown in below Table no. 3

Table 3: Capacitor with Frequency

Mode	Frequency	C_1, C_2
LP	32 KHz 200 KHz	33 pF 15 pF
XT	200 KHz 1MHz 4MHz	47-68 pF 15 pF 15 pF
HS	4MHz 8MHz 20MHz	15 pF 15-33 pF 15-33 pF

ADVANTAGE EFFECT OF OVER CORRECTION

- Power system becomes unstable
- Resonant frequency is below the line frequency
- Current and voltage increase

ADVANTAGES OF IMPROVED POWER FACT

- Reactive power decreases
- Avoid poor voltage regulation
- Overloading is avoided
- Copper loss decreases
- Transmission loss decreases
- Improved voltage control
- Efficiency of applying system and apparatus increases

FUTURE ENHANCEMENTS

The synchronous phase modifier is one of the best mechanisms to refinement of the power factor of the distribution system. The over exited synchronous motor, with light load can also be responsible to upgrade the power factor of the distribution power system. The thesis presented here, concerns the development of various techniques and their validation in different conditions for the enhancement of power quality, using Active Filters. This research work can be extended to a multilevel inverter, implemented for power conditioning. Three phase, three wire system can be extended to three phase four wire system, with different conditions like the zero sequence voltage.

RESULTS

Figure 19: Modal Diagram

Now, we are familiar with how the power factor is one of the essential factors to obtain the stable, reliable, efficient and better performance of the distribution system? If the power factor is within the desire limits, then the real power transfer is better. It is not only economical to the consumer, but also the supplier. Utilities don't need to be given any extra charges, if the power factor is within the desired boundary.

The study & Modeling have been done for minimization of penalty of power consumption, in a power system, by APFC unit.

CONCLUSIONS

Now, we can conclude that the power factor plays a very effective role in the performance of the power system. If the power factor is poor, then it will be responsible for indigent working performance of the subsystems of the distribution line, and also the factories. It originates extra charges to the shopper and the size & cost of the system also might be enhanced. Extra insulation is required for the protection of the system against the huge current supply.

Finally, we draw to close that the power factor must be within the desired operating condition. It should neither more nor poor, and it must be maintained in the proper limit of reliable and stable operation of the system.

REFERANCES

1. P.N. Enjeti and R martinez, “A high performance single phase rectifier with input power factor correction,” IEEE Ttrans. Power Electron.. Vol. 11, No.2, Mae. 2003. pp 311-317
2. J.G. cho, J.W. Won, H.S Lee, “Reduced conduction loss zero-voltage-transition power factor correction converter with low cost,” IEEE Trans. Industrial Electron. Vol. 45, no. 3, Jun. 2000, pp395-400
3. “The 8051 microcontroller and Embedded System” by Mohammad Ali Mazidi and Janice Gillispie Mazidi
4. 8052 simulator for windows version 3.604 25JUN1999, sim 8052@vaultbbs.com, www.fsinc.com, www.keil.com
5. Electric power industry reconstructing in India, Present scenario and future prospects, S.N Singh, senior member, IEEE and S.C. Srivastava, Senior member, IEEE
6. “Power factor correction”, Reference designed from Freescale http://www.freescale.com.
7. Lessons In Electric Circuits Volume II, Sixth Edition, Tony R. Khuphaldt, 2007
8. Power Factor Correction, Ralph A. Frye III, P.E., http://www.com/aboutus/powerfactor.html
9. Power Factor, L.M. Photonics Ltd, http:// imphotonics .com/pwrfact. html? gclid=CJbHjdTMjosCFSUeGAodtRe8VQ
10. Sharad Chandra Rajpoot, Prashant Singh Rajpoot and Durga Sharma,” Power system Stability Improvement using Fact Devices”, International Journal of Science Engineering and Technology research ISSN 2319-8885 Vol.03, Issue. 11, June-2014, Pages: 2374-2379.
11. Sharad Chandra Rajpoot, Prashant Singh Rajpoot and Durga Sharma, “Summarization of Loss Minimization Using FACTS in Deregulated Power System”, International Journal of Science, Engineering and Technology research ISSN 2319-8885 Vol.03, Issue.05, April & May-2014, Pages: 0774-0778.
12. Sharad Chandra Rajpoot, Prashant Singh Rajpoot and Durga Sharma, “Voltage Sag Mitigation in Distribution Line using DSTATCOM” International Journal of Science, Engineering and Technology research ISSN 2319-8885 Vol.03, Issue.11, April June-2014, Pages: 2351-2354.
13. Prashant Singh Rajpoot, Sharad Chandra Rajpoot and Durga Sharma, “Review and utility of FACTS controller for traction system”, International Journal of Science, Engineering and Technology research ISSN 2319-8885 Vol.03, Issue.08, May-2014, Pages: 1343-1348.
14. Sharad Chandra Rajpoot, Prashant Singh Rajpoot and Durga Sharma, “A typical PLC Application in Automation”, International Journal of Engineering research and Technology ISSN 2278-0181 Vol.03, Issue.6, June-2014.
15. Iba K. (1994) ‘Reactive power optimization by genetic algorithms’, IEEE Trans on power systems, May, Vol.9, No.2, pp. 685-692.
16. Sharad Chandra Rajpoot, Prashant Singh Rajpoot and Durga Sharma,“21st century modern technology of reliable billing system by using smart card based energy meter”, International Journal of Science, Engineering and Technology research, ISSN 2319-8885 Vol.03, Issue.05, April & May-2014, Pages: 0840-0844.

17. Prashant Singh Rajpoot, Sharad Chandra Rajpoot and Durga Sharma, “wireless power transfer due to strongly coupled magnetic resonance”, International Journal of Science, Engineering and Technology research ISSN 2319-8885 Vol.03,. 05, April & May-2014, Pages: 0764-0768.