ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

Impedance Coordinating Wireless Power Transfer via Magnetic Resonant Coupling

Pushpendra Kumar[1], Ritesh Diwan[2,]

M.E Student, Department of Power Electronics (Electrical Engineering), Raipur Institute of Technology, Raipur, Chhattisgarh, India

Associate Professor, Department of Power Electronics (Electrical Engineering), Raipur Institute of Technology, Raipur, Chhattisgarh, India

ABSTRACT: The primary goal of this task to propose impedance coordinating and control division system and summed up for subjective number of beneficiaries and self-assertive number of repeaters. Impedance coordinating and control division conditions are communicated as far as coupling coefficient, which is the regularly utilized representation. Keeping in mind the end goal to actualize controllable force division without changing the position of every curl, the outside coupling coefficients of the collectors can be altered by embeddings an impedance inverter circuit in the middle of beneficiary and the relating end resistor.

KEYWORDS: Research on circuits, power transfer, impedance comparison, inverters, magnetic circuits, resonance, RLC circuit analysis

I. INTRODUCTION

A perfect wireless power transfer must have the capacity to exchange control productively paying little respect to the less than desirable end in the powerful area. In any case, the attractive full coupling system is productive just in an altered separation and introduction. At the point when the beneficiary is moved far from its ideal working point, the productivity tumbles off quickly. Besides, in a wireless power transfer comprising of different beneficiaries, collectors closer to the transmitter have a tendency to retain more power. Numerous past approaches have proposed diverse approaches to determine the proficiency issue however not on force appropriation. Approaches investigate the conceivable outcomes of multireceiver framework utilizing either identical circuit or coupled mode hypothesis. Productivity examination for distinctive conditions is given, however systems for enhancing effectiveness and power conveyance are not proposed. Regularly, a wireless power transfer is examined utilizing an equal circuit; be that as it may, the comparisons for framework with more loops rapidly get to be intricate or thorough to be dissected. In this manner, a bandpass channel representation is proposed. The configuration comparisons are straightforward even with numerous repeaters included the force exchange framework. Notwithstanding, the technique is unreasonable because of inapplicability to multireceiver, and the position of every loop should be controllable. Different endeavors incorporate including and altering a medium curl to enhance the exchange productivity. The system, in any case, is restricted to particular cases. A recurrence following system, where the recurrence of the source is shifted for distinctive conditions, has likewise been proposed.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

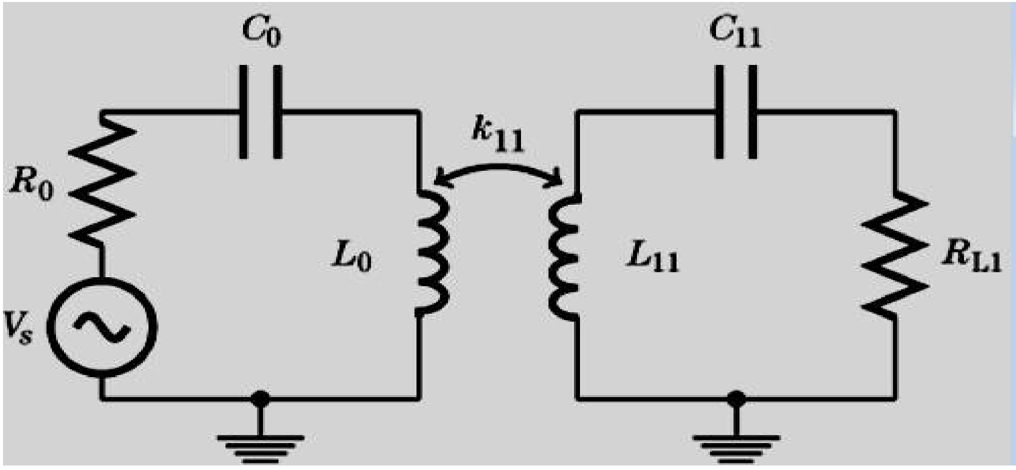

Figure.1. One End Transmitter and Receiver Wireless Power Transfer

In pragmatic applications, the wireless power transfer ought to stay inside an admissible mechanical, investigative, and therapeutic band which is limited. Along these lines, tuning recurrence is not a practical system for wireless power transfer. In impedance coordinating circuit is embedded in the transmitter side taking into account a comparable circuit model. Exchange proficiency is advanced paying little respect to the less than desirable end. In any case, controllable force circulation is unrealistic utilizing this strategy. In a multireceiver framework the exchange effectiveness is critical as well as the force conveyance among the recipients. Power circulation relies on upon both burden impedance and relative positions of collectors to the transmitter. Expecting indistinguishable burdens joined with every beneficiary, the recipient closest to the transmitter has a tendency to retain the vast majority of the force while the uttermost collector may not acquire enough to work legitimately. In this system, a technique for impedance coordinating and controllable force division for a 13.56-MHz framework is proposed. The outline mathematical statements are inferred and after that summed up for subjective number of beneficiaries and self-assertive number of repeaters. Reproductions utilizing LTspice and investigations are performed to approve the new technique.

A. Impedance Inverter

An impedance inverter is a kind of circuit which has information impedance contrarily relative to the impedance joined at the flip side. There are numerous applications and numerous sorts of impedance inverter. In this system, an impedance inverter is utilized to speak to the coupling in the middle of loops and impedance change. Consider the identical circuit of one-transmitter and one collector remote force move appeared in Fig. 1. While coupling quality, k11 is communicated in common inductance terms; the identical circuit can be redrawn into Fig. 2.

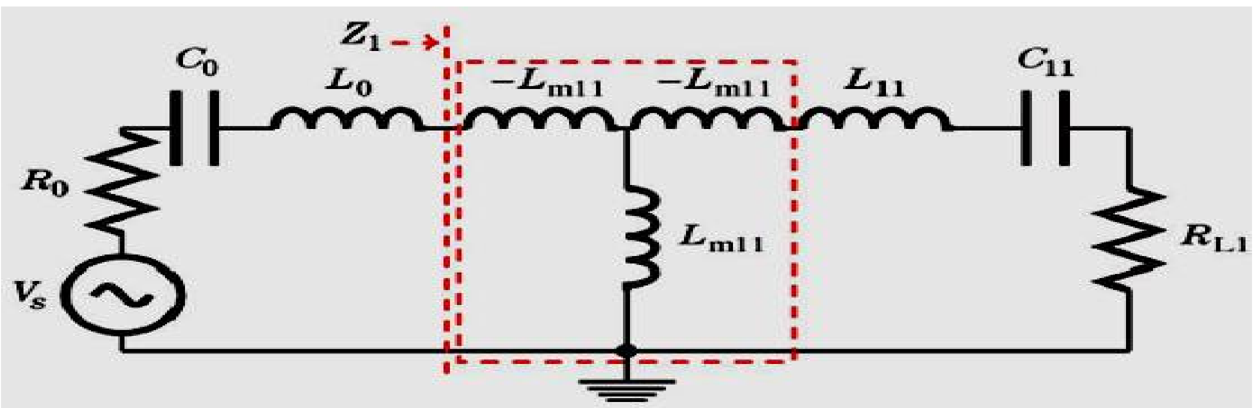

Figure.2. Impedance Inverter as Coupling Strength Representation

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

B. System with Repeaters

Albeit wireless power transfer by means of attractive resonant coupling can transmit control all the more effectively contrasted with incitement strategy, the transmittable separation is still restricted to a couple meters. This extent is extendable utilizing repeater curls.

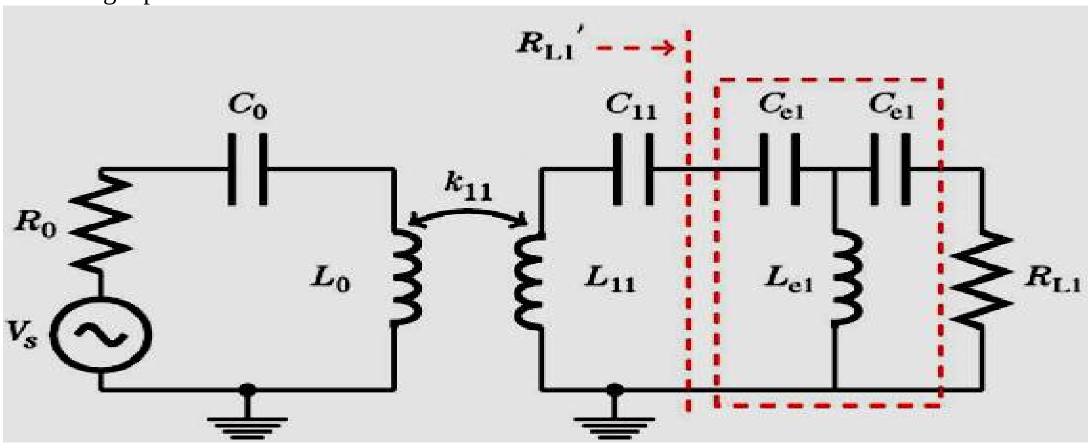

Figure.3. Impedance Inverter for Impedance Transformation

Be that as it may, when more curls are included into the framework, existing identical circuit mathematical statements get to be entangled. Paper resorts to hunt calculations, and utilizes a PC helped plan. The bandpass channel outline technique is straightforward yet illogical because of stringent conditions applied by bandpass channel mathematical statements. In this paper power division routines as well as another impedance coordinating strategy for wireless power transfer with repeaters are proposed. The new technique consolidates the upsides of both existing comparable circuit and bandpass channel system.

C. Extension Work

The future, the model can likewise be changed with multi collector framework to build the utilization at the recipient side. The quantity of reverberation recipients likewise create more prominent attractive field which is then given to the heap. It holds the considerable potential to control huge apparatus like eliminating so as to control engines and charging electric autos the links utilized for controlling or charging and afterward a DC/DC converter will be actualized at the collector for charging voltage load, for example, batteries and super capacitors and power control if the vehicle goes somewhat off track.

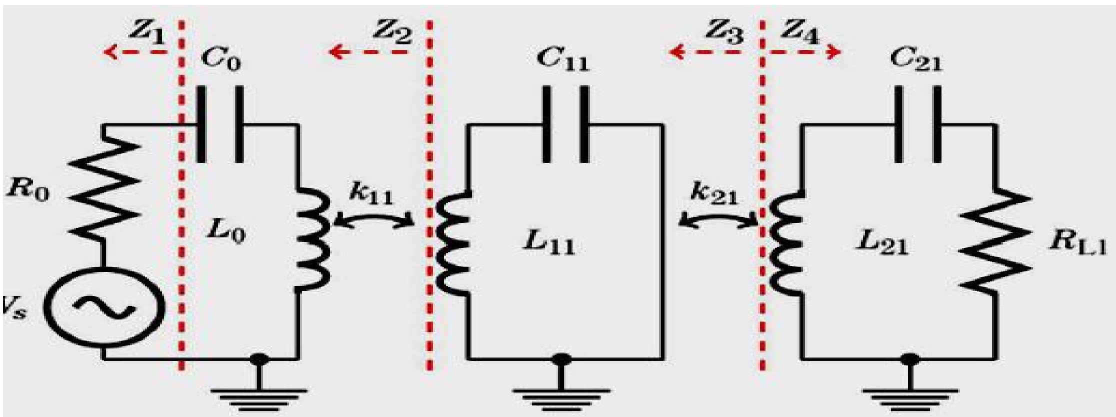

Figure.4. Equivalent circuit for wireless power transfer with repeater

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

D. Existing System

In the past examination have proposed distinctive approaches to determine the effectiveness issue however not on force circulation. Which are investigate the potential outcomes of multi beneficiary framework utilizing either proportional circuit or coupled mode hypothesis . Productivity examination for diverse conditions is given, however techniques for enhancing effectiveness and power dissemination are not proposed. Frequently, a wireless power transfer is dissected utilizing a proportional circuit.

DISADVANTAGES:

- ✓ Power transmission range is low
- ✓ Power misfortunes high
- ✓ Low load effectiveness

E. Proposed System

In this proposed framework, offers a straightforward and quick count technique for impedance coordinating and control division for wireless power transfer comprising of various repeaters and beneficiaries. In genuine usage, on the other hand, careful component values don't exist. A Monte Carlo reproduction is performed to examine the affectability of the proposed system toward part varieties. In this framework power division routines as well as another impedance coordinating system for wireless power transfer with repeaters is proposed. This proposed technique consolidates the upsides of both existing comparable circuit and band pass channel strategy.

ADVANTAGES:

- ✓ Transmitting range is high contrast with past techniques
- ✓ Power enhancement included

II. RELATED WORK

In "Analysis, experimental results, and range adaptation of magnetically coupled resonators for wireless power transfer [1]", the authors "A. P. Sample, D. A. Meyer, and J. R. Smith" Quoted as: Wireless power technology offers the promise of cutting the last cord, allowing users to seamlessly recharge mobile devices as easily as data are transmitted through the air. Initial work on the use of magnetically coupled resonators for this purpose has shown promising results. We present new analysis that yields critical insight into the design of practical systems, including the introduction of key figures of merit that can be used to compare systems with vastly different geometries and operating conditions. A circuit model is presented along with a derivation of key system concepts, such as frequency splitting, the maximum operating distance (critical coupling), and the behavior of the system as it becomes undercoupled. This theoretical model is validated against measured data and shows an excellent average coefficient of determination of 0.9875. An adaptive frequency tuning technique is demonstrated, which compensates for efficiency variations encountered when the transmitter-to-receiver distance and/or orientation are varied. The method demonstrated in this paper allows a fixed-load receiver to be moved to nearly any position and/or orientation within the range of the transmitter and still achieve a near-constant efficiency of over 70% for a range of 0-70 cm.

In "Novel band-pass filter model for multi-receiver wireless power transfer via magnetic resonance coupling and power division [2]", the authors "K. E. Koh, T. C. Beh, T. Imura, and Y. Hori" Quoted as: Recently medium range wireless power transfer had been extensively researched for applications such as consumer electronics products, portable devices, robotics and electric vehicles. Coupled-mode theory and equivalent circuit model representations are the more recognized models used to describe and design the system mathematically. Band-pass filter model is relatively new, using this model the physical wireless power transfer system is representable in relatively simpler equations compared to coupled-mode theory and equivalent circuit model. Methodology for multi-receiver is derived using band-pass filter model and impedance matching is achieved. Newly proposed methodology allows controllable power division among receivers. Controllable power division is a very important feature for an effective wireless power transfer system in real applications. When powering multiple devices, the devices nearer to the transmitter tend to absorb more power

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

compared to the farther devices, past literature had never addressed this issue of wireless power transfer system. With this new methodology, not only impedance matching is achieved, but also the ratio of power delivered to each receiver end is controllable.

In "Magnetic resonant coupling as a potential means for wireless power transfer to multiple small receivers [3]", the authors "B. L. Cannon, J. F. Hoburg, D. D. Stancil, and S. C. Goldstein" Quoted as: Wireless power transfer via magnetic resonant coupling is experimentally demonstrated in a system with a large source coil and either one or two small receivers. Resonance between source and load coils is achieved with lumped capacitors terminating the coils. A circuit model is developed to describe the system with a single receiver, and extended to describe the system with two receivers. With parameter values chosen to obtain good fits, the circuit models yield transfer frequency responses that are in good agreement with experimental measurements over a range of frequencies that span the resonance. Resonant frequency splitting is observed experimentally and described theoretically for the multiple receiver system. In the single receiver system at resonance, more than 50% of the power that is supplied by the actual source is delivered to the load. In a multiple receiver system, a means for tracking frequency shifts and continuously retuning the lumped capacitances that terminate each receiver coil so as to maximize efficiency is a key issue for future work.

In "Simultaneous mid-range power transfer to multiple devices [4]", the authors Quoted as: Electromagnetic resonators strongly coupled through their near-fields [A. Karalis, J. D. Joannopoulos, and M. Soljačić, Ann. Phys.323, 34 (2008); A. Kurs, A. Karalis, R. Moffatt, J. D. Joannopoulos, P. Fisher, and M. Soljačić, Science317, 83 (2007)] are able to achieve efficient wireless power transfer from a source to a device separated by distances multiple times larger than the characteristic sizes of the resonators. This midrange approach is therefore suitable for remotely powering several devices from a single source. We explore the effect of adding multiple devices on the tuning and overall efficiency of the power transfer, and demonstrate this scheme experimentally for the case of coupling objects of different sizes: a large source (1 m2 in area) powering two smaller devices (each ≃0.07 m2 in area).

In "Analysis of wireless energy transfer to multiple devices using CMT [5]", the authors "J. W. Kim, C. Son, D. H. Kim, K. H. Kim, and Y. J. Park" Quoted as: In this paper, characteristics of wireless energy transfer to multiple devices is presented. Using the coupled mode theory (CMT), coupling behavior of resonant coils is analyzed, by assuming that resonant coils between devices are independent. Maximum efficiency of energy transfer to resonant coils of devices and time for the maximum energy transfer are obtained. It is shown that the energy transfer to each device is divided with the rate of the square of the coupling coefficient. It is also shown that the number of devices should be decided carefully to design the wireless energy transfer system since total efficiency is likely to be saturated despite devices increasing. For verification, an equivalent circuit model is derived and using the model, reflection and transmission are simulated. Theoretical results are compared with simulated ones.

III.BLOCK DIAGRAM

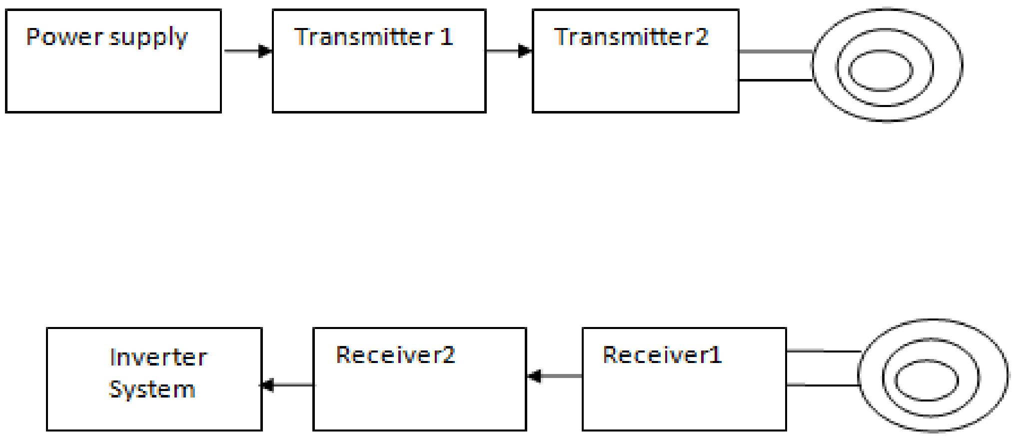

Figure.5. Block Diagram

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

IV. CIRCUIT DIAGRAM

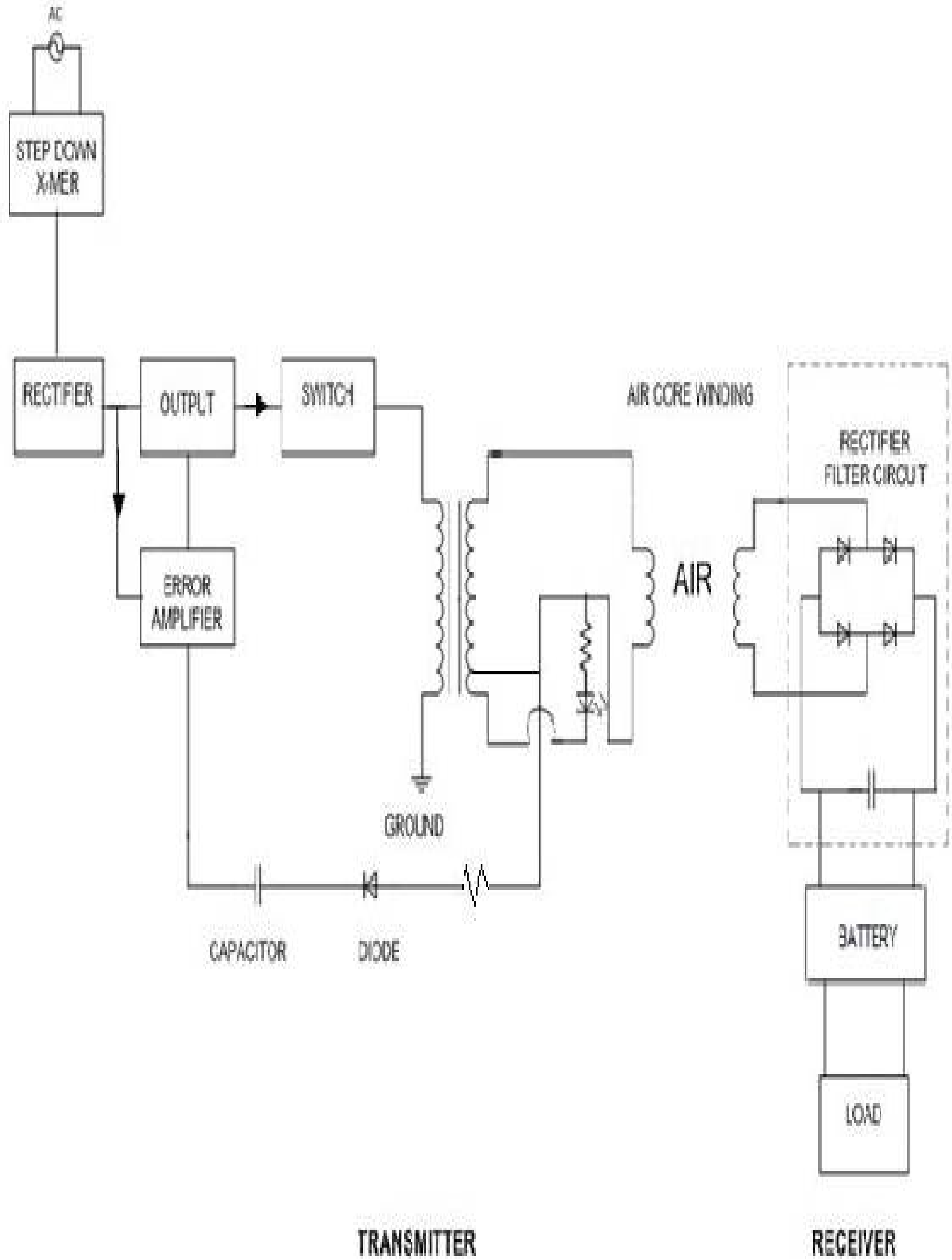

Figure.6. Circuit Diagram

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

V. EXPERIMENTAL RESULTS

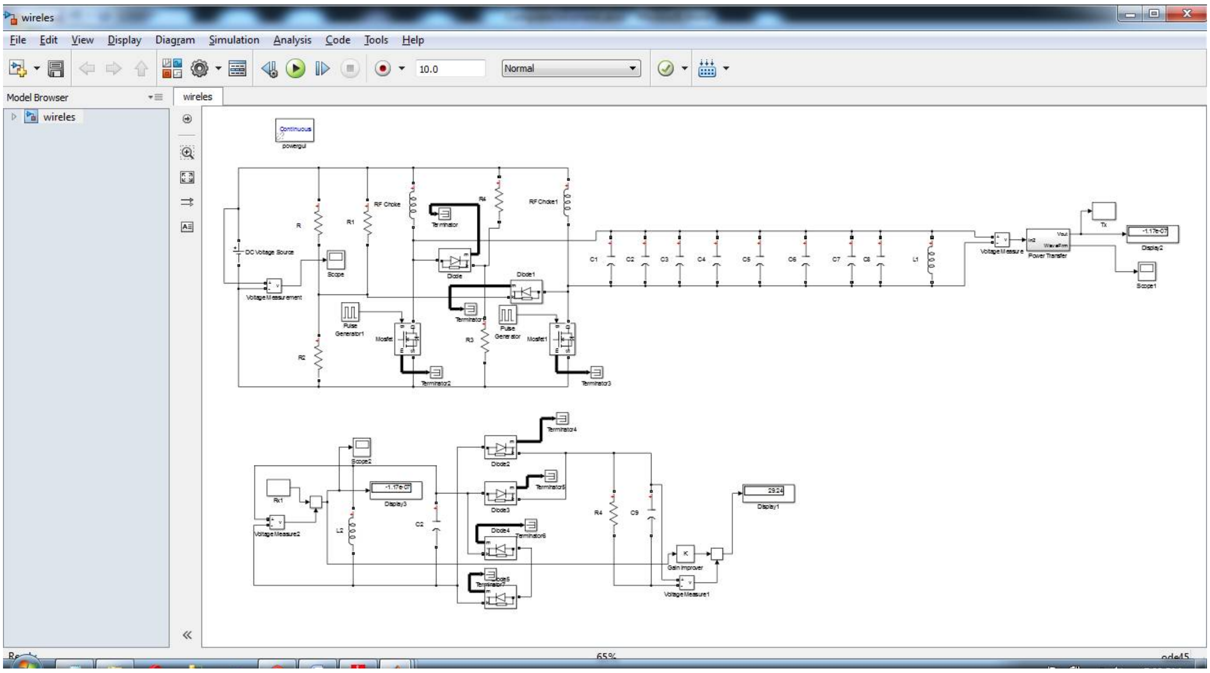

Figure.7. Overall Design

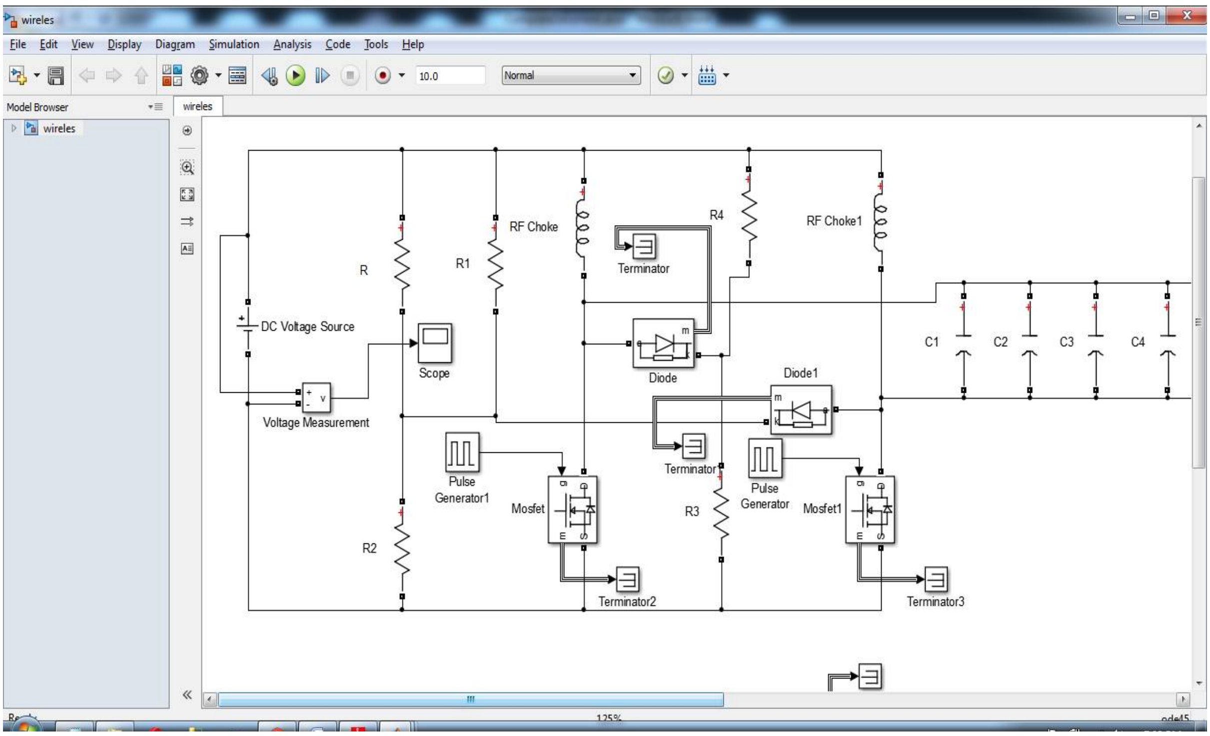

Figure.8. Transmitter End-Detailed View

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

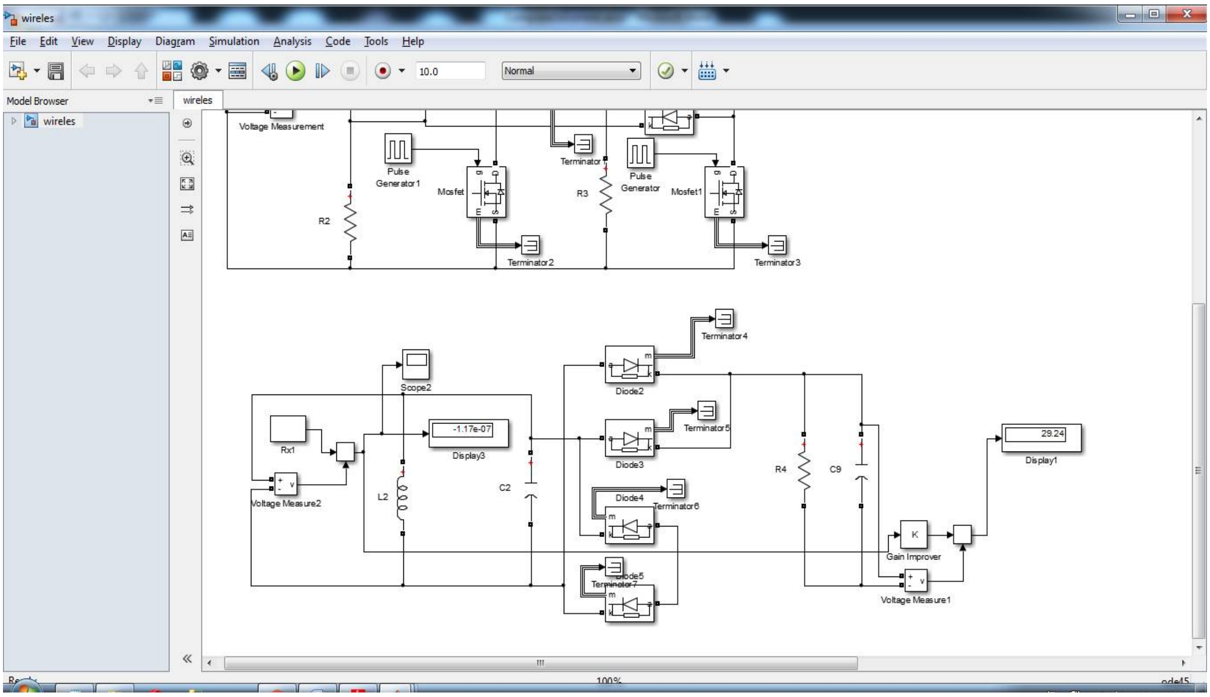

Figure.9. Receiver End - Detailed View

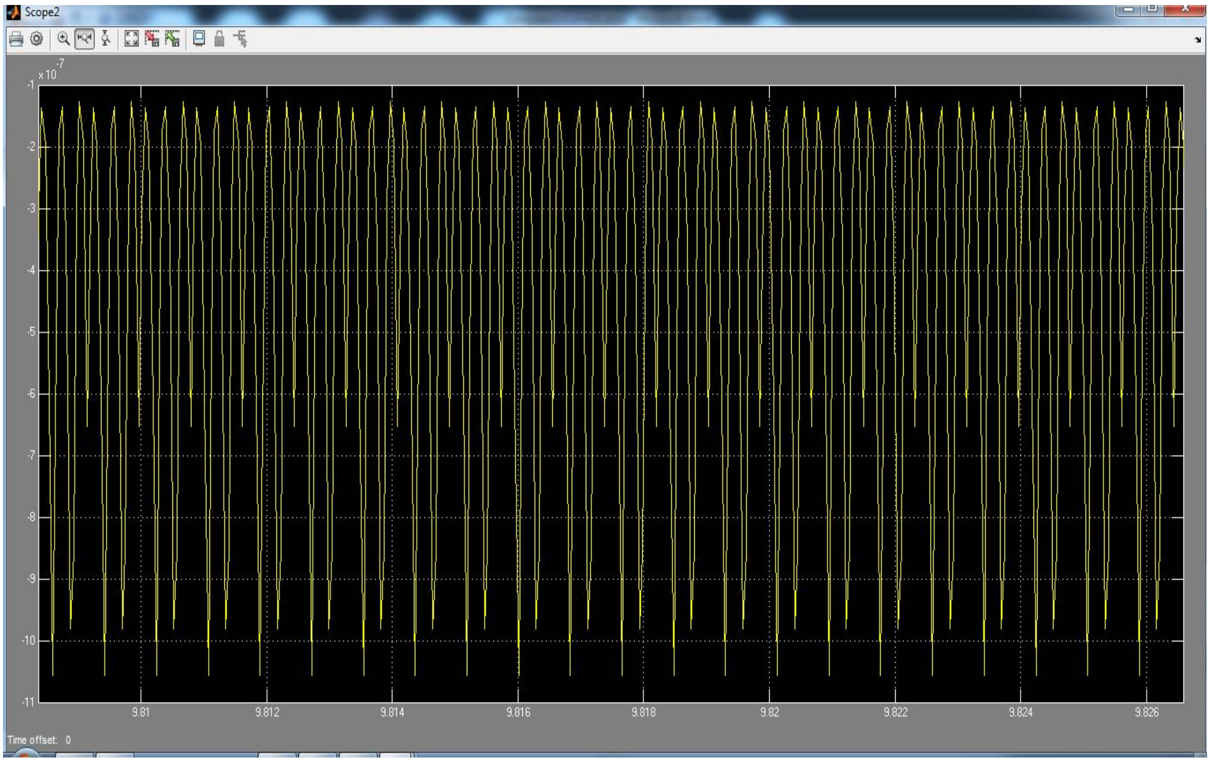

Figure.10. Frequency Output

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

VI. CONCLUSION

Another impedance coordinating and control division system has been proposed and summed up for discretionary number of beneficiaries and subjective number of repeaters. Because of uniform mathematical statements came about while utilizing impedance inverter representation, the outline comparisons are basic. Impedance coordinating and control division conditions are communicated as far as coupling coefficient, which is the regularly utilized representation. So as to execute controllable force division without changing the position of every loop, the outer coupling coefficients of the recipients can be adjusted by embeddings an impedance inverter circuit in the middle of beneficiary and the comparing end resistor.

REFERENCES

[1] A. P. Sample, D. A. Meyer, and J. R. Smith, "Analysis, experimental results, and range adaptation of magnetically coupled resonators for wireless power transfer," IEEE Trans. Ind. Electron., vol. 58, no. 2, pp. 544–554, Feb. 2011.
[2] K. E. Koh, T. C. Beh, T. Imura, and Y. Hori, "Novel band-pass filter model for multi-receiver wireless power transfer via magnetic resonance coupling and power division," in Proc. 13th Annu. IEEE WAMICON, pp. 1–6.
[3] B. L. Cannon, J. F. Hoburg, D. D. Stancil, and S. C. Goldstein, "Magnetic resonant coupling as a potential means for wireless power transfer to multiple small receivers," IEEE Trans. Power Electron., vol. 24, no. 7, pp. 1819–1825, Jul. 2009.
[4] A. Kurs, R. Moffatt, and M. Soljacic, "Simultaneous mid-range power transfer to multiple devices," Appl. Phys. Lett., vol. 96, no. 4, pp. 044102-1–044102-3, Jan. 2010.
[5] J. W. Kim, C. Son, D. H. Kim, K. H. Kim, and Y. J. Park, "Analysis of wireless energy transfer to multiple devices using CMT," in Proc. APMC, 2010, pp. 2149–2152.
[6] T. Imura, "Study on maximum air-gap and efficiency of magnetic resonant coupling for wireless power transfer using equivalent circuit," in Proc. IEEE ISIE, 2010, pp. 3664–3669.
[7] T. Beh, M. Kato, T. Imura, S. Oh, and Y. Hori, "Automated impedance matching system for robust wireless power transfer via magnetic resonance coupling," IEEE Trans. Ind. Electron., vol. 60, no. 9, pp. 3689–3698, Sep. 2013.
[8] T. Imura and Y. Hori, "Maximizing air gap and efficiency of magnetic resonant coupling for wireless power transfer using equivalent circuit and Neumann formula," IEEE Trans. Ind. Electron., vol. 58, no. 10, pp. 4746–4752, Oct. 2011.
[9] M. Dionigi and M. Mongiardo, "CAD of efficient wireless power transmission systems," in IEEE MTT-S Int. Microwave Symp. Dig., pp. 1–4.
[10] S. Cheon, H. Kim, S. Y. Kang, M. L. Lee, J. M. Lee, and T. Zyung, "Circuit-model-based analysis of a wireless energy-transfer system via coupled magnetic resonances," IEEE Trans. Ind. Electron., vol. 58, no. 7, pp. 2906–2914, Jul. 2011.

BIOGRAPHY

MR. PUSHPENDRA KUMAR is a Master Degree Student in the Department of Power Electronics (Electrical Engineering) in Raipur Institute of Technology, Raipur, Chhattisgarh, India. His areas of interest are Power Electronics, Power Point Tracking, Power Systems and Electrical Machine Engineering.

MR. RITESH DIWAN, Assistant Professor, Department of Power Electronics (Electrical Engineering) in Raipur Institute of Technology, Raipur, Chhattisgarh, India. His areas of research areas are Power Systems, Electrical Machine Engineering, Power Drives and Control Systems.