

Result Analysis on New Controller for Bi-Directional Wireless Power Transfer Systems

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Abstract - Challenges and opportunities remain in the design and deployment of WPT EV systems. Dynamic wireless charging offers opportunities for sustaining the battery charge while driving so that the large battery pack that represents a bottleneck for deploying EVs can be eliminated and range anxiety will be reduced. The environmental, economic and societal impacts of large scale infrastructure deployment and performance in terms of energy efficiency, durability, and reliability must be carefully evaluated for prospective real-world deployment of dynamic WPT EVs. Stationary WPT for residential and commercial charging is expected to have earlier wide spread adoption than dynamic charging given its technical maturity and economic feasibility, while dynamic WPT could be implemented gradually if the market develops enough to significantly lower the high initial infrastructure cost.

Keywords- Wireless power transfer, electric vehicles, Sustainability, Environmental impact; Energy efficiency

I. INTRODUCTION

The wireless power and data transfer have become the most craved technology to increase the lifetime and usage of implants in various applications. Different WPT techniques are investigated in the literature ranging from ultrasonic, thermoelectric, piezoelectric, capacitive and inductive coupling based power transfer. Among all the techniques the inductive and capacitive coupling method has been the most popular in the research community due to the higher power transfer efficiency.

Even though the ultrasonic method offers better efficiency; it is not suitable for deep implant applications due to the penetration issue in bones and skull. The inductive coupling was first used in biomedical applications to transfer the power to an artificial heart and then widely employed to different implants. Further to improve the power transfer rate and range of operation in inductive coupling, the magnetic resonant technique is examined by operating the coils at a resonant frequency.

The power transfer efficiency of the magnetic resonant coupling predominantly depends on the quality factor of the coil and coupling between the coil. However, the Tx and Rx coils are connected with AC source and load, the resistance on the source and load port limit the quality factor of the coil. Similarly, the coupling depends on the relative distance between the coil, dimension and physical properties of the surrounding. Therefore, to boost up the power transfer efficiency, the supplementary relay coil is

the device and losses due to an increase in coil resistance, which reduces the power delivered to the load. The capacitive coupled power transfer also examined for the high and low power applications as an alternative to inductive coupling. The number of plates required and limited range constraints restricts the capacitive coupling in low power applications.

II. PROPOSED METHOD

1. This proposes a new controller, located on the pickup side of BD-WPT systems, to overcome the aforementioned drawbacks.
2. The proposed technique uses the active and reactive power generated by the pickup side converter to achieve synchronization between the primary and pickup sides while regulating the power flow in both directions, without any wireless communications for controlling power transfer.
3. It allows for the operation of the pickup converter at the predetermined power level while maintaining reactive power generation at the resonant tank to minimum even under off-tuned conditions due to pad-misalignments and variations in component values.
4. Theory and implementation of the new controller are described in detail, and its robustness is demonstrated through sensitivity analysis using a mathematical model. Both simulated and experimental results, gathered from a 1 -kW prototype bidirectional WPT system with a single pickup, are presented to show that the proposed controller is easy to implement and applicable for BD-WPT systems.

attached to the source and load side. On the other hand, the additional coil on both sides will increase the size of

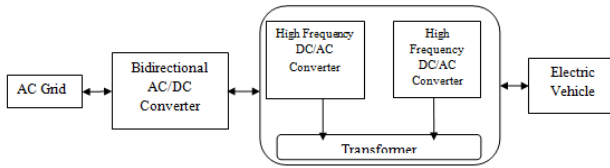


Fig.1. Flow diagram of bidirectional WPT system.

III. SIMULATION RESULT

The proposed a new controller, located on the pickup side of BD-WPT systems, to overcome the aforementioned drawbacks. The proposed technique uses the active and reactive power generated by the pickup side converter to achieve synchronization between the primary and pickup sides while regulating the power flow in both directions, without any wireless communications for controlling power transfer. It allows for the operation of the pickup converter at the predetermined power level while maintaining reactive power generation at the resonant tank to minimum even under off-tuned conditions due to pad-misalignments and variations in component values. Theory and implementation of the new controller, and its robustness is demonstrated through sensitivity analysis using a mathematical model. Both simulated and experimental results, gathered from a 1-kW prototype bidirectional WPT system with a single pickup, are presented to show that the proposed controller is easy to implement and applicable for BD-WPT systems.

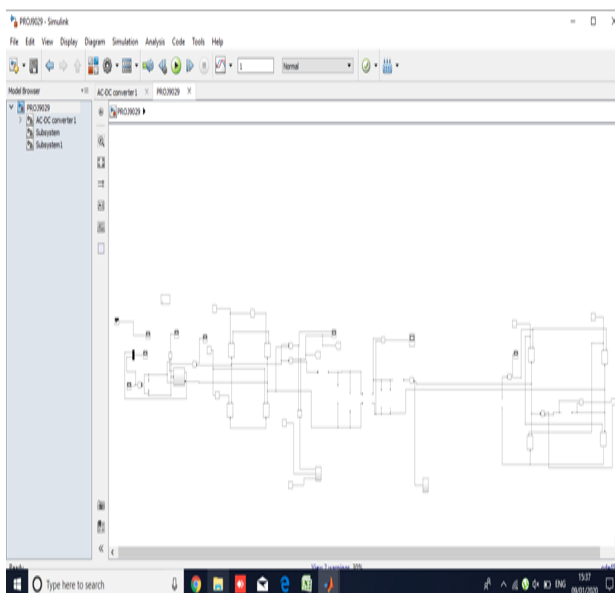


Fig.2. Proposed Simulation Model.

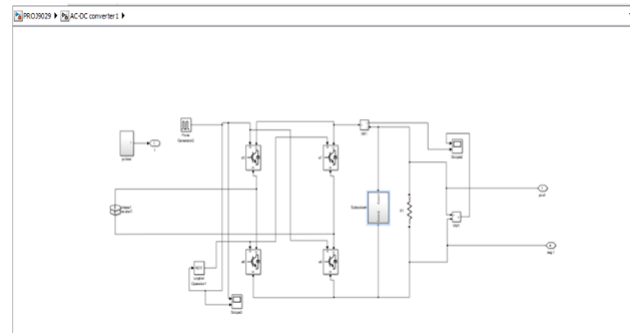


Fig.3. Simulation Model of AC-DC Converter.

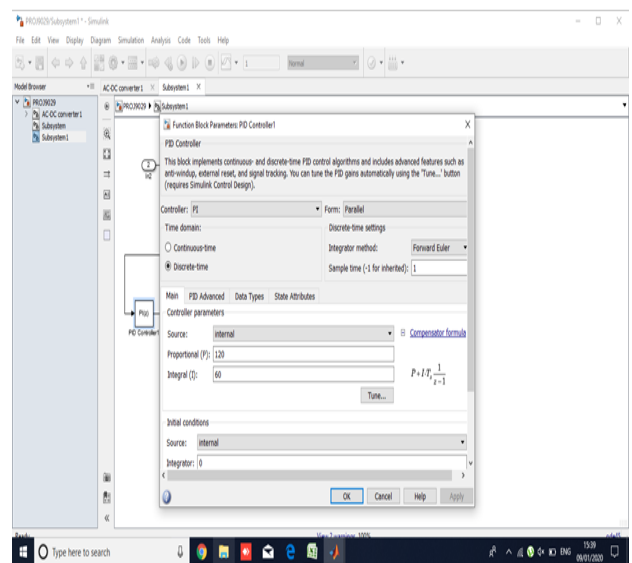


Fig.4. Description of Using PI Controller.

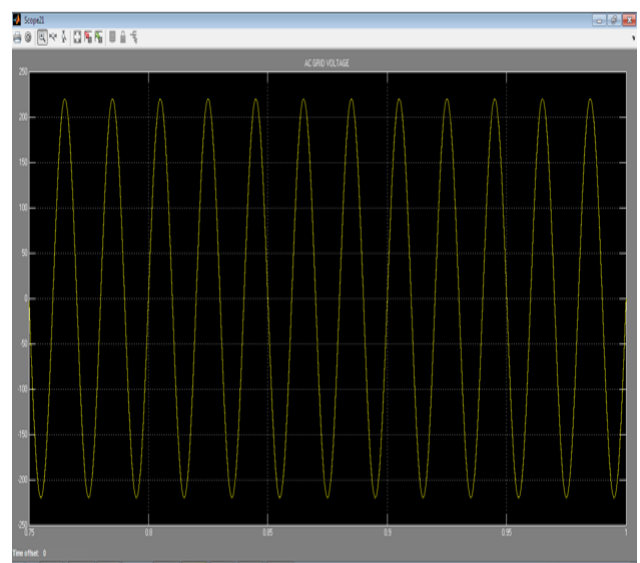


Fig.5. Simulation result of AC Grid Voltage.

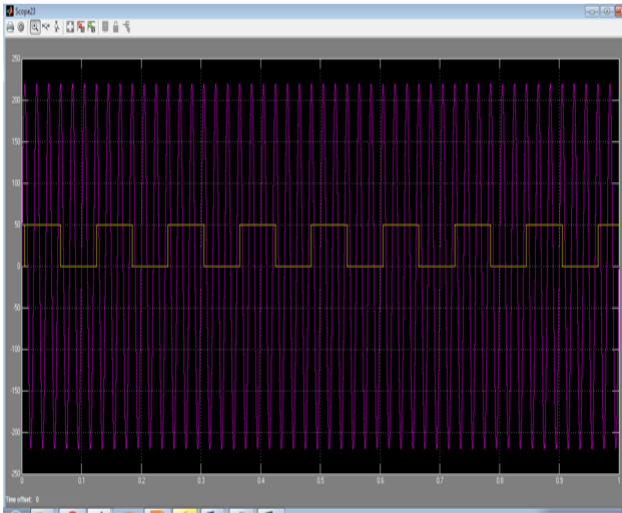


Fig.6. Dc Voltage waveform.

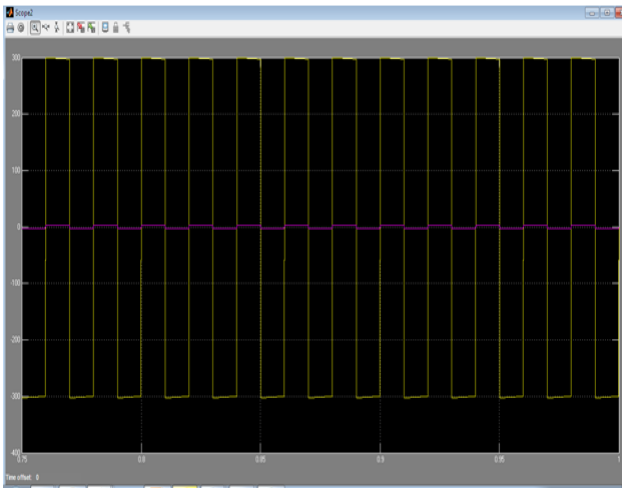


Fig.7. Output of proposed system.

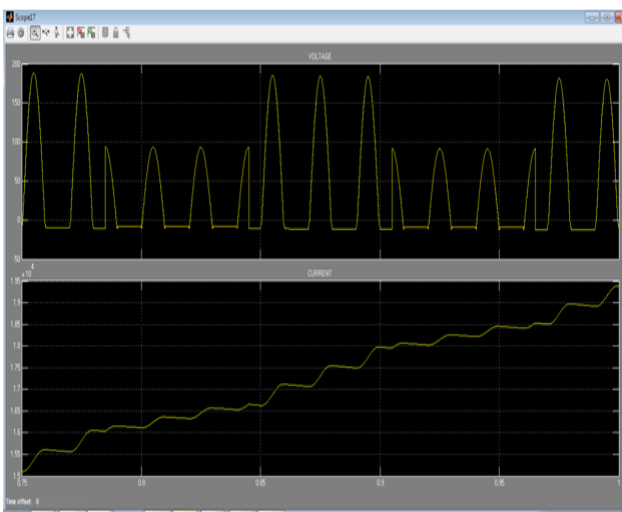


Fig.8. Voltages and Current Waveform.

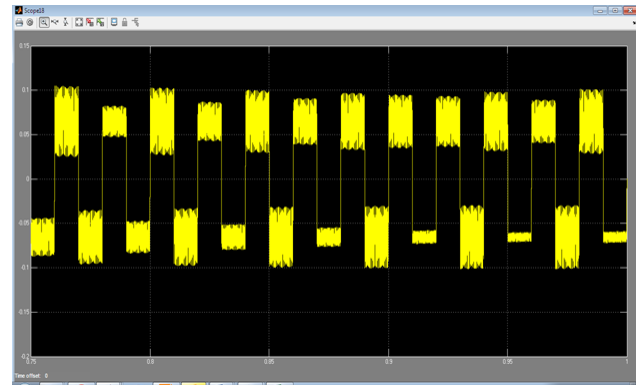


Fig.9. Output of electric vehicles.

Table I: Parameters of Simulation Model

Parameter		Values
Nominal power and frequency		[1e6 60]
Winding 1 parameters		[631 0.02 0.02]
Winding 2 parameters		[1200 0.02 0.02]
Magnetization resistance and Inductance		[0.2 15]
Internal Resistance		1e-3
Snubber resistance		1e5
Snubber capacitance		Inf
AC Voltage Source	Peak amplitude	220
	Phase	0
	Frequency	50
	Sample time	0
Pulse Generato	Amplitude	50
	Period	0.02*6
VCO	Output amplitude	5
	Quiescent frequency	60
	Input sensitivity	60/300
	Initial Phase	0

IV. CONCLUSION

A novel controller has been proposed to regulate the power flow in BD-WPT systems. The proposed controller, located on the pickup side, utilizes measured active and reactive power generated by the pickup converter to establish precise synchronization between the primary and pickup as well as to regulate the power flow in both directions without a dedicated communication link. The novel PQ based control technique has been described in detail, analyzing its sensitivity to variations in system parameters. Simulated and experimental results of a prototype 1-kW BD-WPT system have been presented to demonstrate the applicability and robustness of the proposed controller.

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