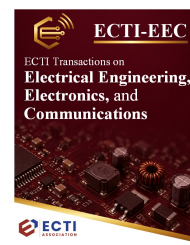


Improved Inductive WPT System Modeling with a ZVDS Class-DE Current-Driven Full-Bridge Rectifier for Accurate Conduction Loss Analysis

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ABSTRACT

This paper presents an improved inductive wireless power transfer (WPT) system model with a zero-voltage and zero-derivative-switching Class-DE current-driven full-bridge rectifier for accurate conduction loss analysis. Conventional models typically assume a near-infinite magnetizing inductance with a negligible magnetizing current, which fails in applications where a low magnetizing inductance induces a very high magnetizing current. This elevated magnetizing current causes a significant phase lag of the input current relative to the input voltage of the transmitter compensation network, leading to substantial reactive power and increased conduction losses. Accordingly, the proposed model includes the coupling coefficient and these magnetizing effects into the key equations. To validate the proposed model, the developed inductive WPT converter utilizing a phase-shift controller at an 88-kHz switching frequency has been experimentally evaluated under a 360-V input voltage and 350-V output voltage, covering an output power range from 0.2 kW to a rated power of 1.8 kW at a 50-mm transfer distance.

Keywords: Inductive wireless power transfer, inductive WPT modeling, conduction loss analysis, ZVDS Class-DE current-driven full-bridge rectifier.

1. INTRODUCTION

Inductive wireless power transfer (WPT) has become highly popular for modern power delivery applications [1]-[12], offering significant advantages in terms of electrical isolation, safety, and operational convenience. As industry demands move toward higher power density and superior efficiency, the need for highly precise analytical models becomes paramount, particularly because accurate power converter design directly leads to precise thermal management [13]-[18].

Among various power conversion topologies [1]-[18], the Class-DE current-driven full-bridge rectifier has gained considerable traction due to its ability to achieve soft-switching operations, such as zero-voltage switching and zero-derivative switching (ZVDS), which are critical for minimizing switching losses and noise at high frequencies [4], [9]. Recently, an accurate and systematic mathematical model for designing series-series resonant compensation networks utilizing a ZVDS Class-DE current-driven full-bridge rectifier was proposed in [4], [9]. This conventional model derived key parameters, such as normalized input impedance and diode conduction duty ratios, using steady-state time-domain analysis combined with Fourier series.

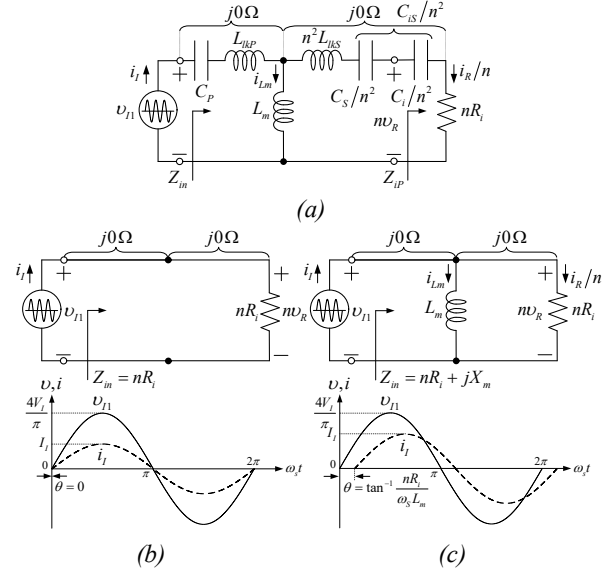


Fig.1: Derivation and comparison of equivalent models under resonant condition. (a) Initial simplified equivalent circuit of the inductive WPT system, (b) Conventional model neglecting the magnetizing effects, and (c) Proposed model incorporating the magnetizing inductance L_m and its associated phase lag θ .

While the model in [4], [9] provided a feasible solution for reducing reactive power, its analytical boundary was limited by the assumption of a loosely coupled transformer operating under an idealized near-infinite magnetizing inductance with a negligible magnetizing current. Under this loosely coupled assumption, the system efficiency was modeled using a pre-defined fixed value, yielding a specific estimated input current of the transmitter compensation network under rated output power conditions. To analyze this system behavior, the simplified equivalent circuit of an inductive WPT system is shown in Fig. 1(a). However, these assumptions fail when the system has a large air gap and loose coupling. In practical inductive WPT systems, a significantly lower magnetizing inductance induces a very high magnetizing current. This elevated magnetizing current causes a large phase lag of the input current relative to the input voltage within the transmitter compensation network. Therefore, excessive reactive power circulates within the system, resulting in a severe increase in conduction losses. Because the model in [4], [9] neglected these magnetizing effects as shown in Fig. 1(b), it underestimates currents and conduction losses. Thus, the calculated efficiency is higher than actual circuit behavior.

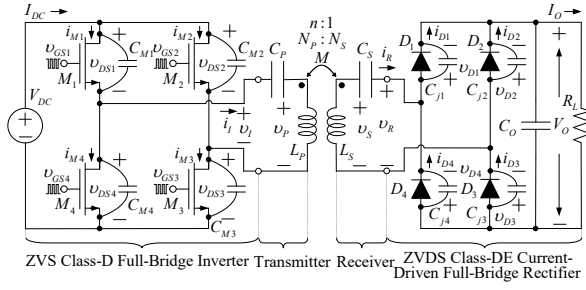


Fig.2: Circuit configuration of inductive WPT system.

To develop the model for practical loose-coupling conditions, this paper presents an improved, extended inductive WPT system model that includes the coupling coefficient and these magnetizing effects directly into the key equations with the ZVDS Class-DE current-driven full-bridge rectifier as presented in Fig. 1(c). As a result, the proposed model achieves highly accurate input current of the transmitter compensation network and conduction loss calculations, successfully eliminating the mathematical estimation errors inherent in the conventional approach. The validity of the proposed model is confirmed through hardware experiments on the developed inductive WPT converter utilizing a phase-shift controller [16] at an 88-kHz switching frequency operating under a 360-V input voltage and 350-V output voltage, covering an output power range from 0.2 kW to 1.8 kW at a 50-mm transfer distance.

The remainder of this paper is organized as follows. Section 2 presents the proposed analytical model and its derivation. Section 3 details the steady state analysis. Section 4 provides the experimental verification and comparative analysis. Finally, Section 5 concludes this paper.

2. ANALYTICAL MODEL AND ITS DERIVATION

A. Topology Description

The schematic of the evaluated inductive WPT system is presented in Fig. 2. On the primary side, a high-frequency zero-voltage switching (ZVS) Class-D full-bridge inverter is fed by a direct current (DC) voltage source from a power-factor correction (PFC) stage. This inverter configuration incorporates four MOSFETs (M_1 , M_2 , M_3 , M_4) with their respective parasitic capacitors (C_{M1} , C_{M2} , C_{M3} , C_{M4}), connected to a transmitter compensation network made of a primary series capacitor C_P and a primary self-inductor L_P . A loosely coupled transformer with a mutual inductance M and a turns ratio of $N_P:N_S = n:1$ transfers energy to the secondary side. The receiver compensation network contains a secondary self-inductor L_S and a secondary series capacitor C_S , which feeds into the ZVDS Class-DE current-driven full-bridge rectifier. This rectification stage comprises four diodes (D_1 , D_2 , D_3 , D_4) with junction capacitors (C_{J1} , C_{J2} , C_{J3} , C_{J4}), a filtering capacitor C_O , and a resistive load R_L . Therefore, the magnetic coupling provides full electrical isolation, with no direct physical connection between the inverter and rectifier stages.

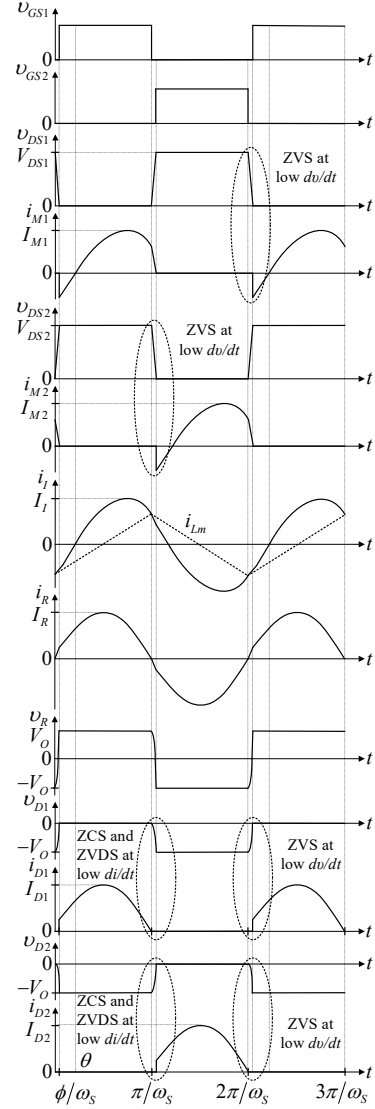


Fig.3: Key waveforms of inductive WPT system.

Figure 3 presents the ideal operational waveforms of the evaluated inductive WPT system, which focuses on two distinct parts: the primary-side ZVS Class-D full-bridge inverter and the secondary-side ZVDS Class-DE current-driven full-bridge rectifier. The gate signals for the MOSFET pairs (M_1 , M_3 and M_2 , M_4) are complementary, non-overlapping rectangular waves (v_{GS1} , v_{GS2} , v_{GS3} , v_{GS4}) featuring a duty ratio of approximately 0.5 at an operating frequency of $f_s = 1/T_s$. Due to the high load quality factor Q_L of both resonant networks, the driving current i_R closely approximates a pure sine wave. Under these conditions, the inverter switches achieve ZVS at a low dv/dt during turn-on. Meanwhile, the rectifier diodes turn on under ZVS with a low dv/dt , and turn off under both zero-current switching (ZCS) and ZVDS at a low di/dt . Consequently, this soft-switching behavior significantly minimizes switching losses and high-frequency noise [19]–[23]. Furthermore, the voltage stress on the diodes is successfully clamped to the output voltage V_O .

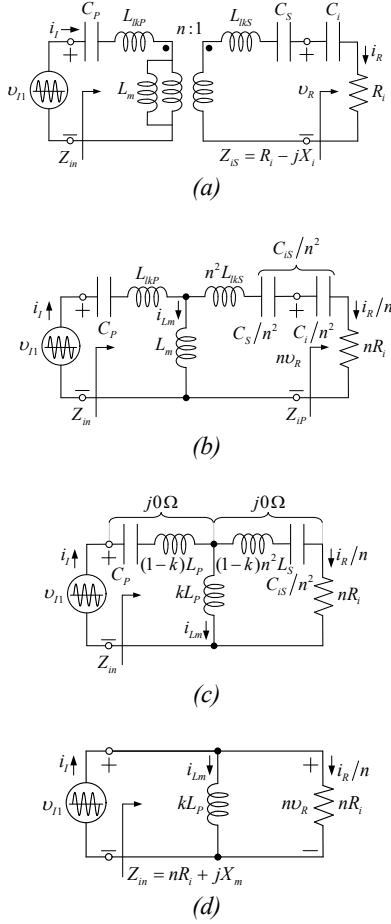


Fig.4: Derivation of simplified equivalent circuit. (a) Initial equivalent circuit with a practical transformer model, (b) Equivalent circuit with all secondary-side components reflected to the primary side, (c) Extended model expressing transformer parameters via coupling coefficient, and (d) Final simplified parallel circuit under resonant operation.

To analyze the inductive WPT system presented in Fig. 2, the following simplified assumptions are made based on the equivalent circuits shown in Figs. 4(a) to (d):

- 1) Each MOSFET is represented by a constant on-state resistance when conducting, and by a junction capacitance during its off-state to account for the ZVS operation.
- 2) Each diode in the conduction state is modeled as a series combination of a constant voltage source and an on-state resistance. In the non-conduction state, it is represented by a junction capacitance associated with the ZVDS operation.
- 3) The loosely coupled transformer transfers power between the primary and secondary coils via a mutual inductance M .
- 4) All passive components are assumed to be linear, time-invariant, and ideal. The leakage inductances of the loosely coupled transformer are utilized directly as the resonant components in the compensation networks.

- 5) The quality factors Q_L of both the primary and secondary resonant circuits are sufficiently high to ensure that the currents flowing through them remain purely sinusoidal.
- 6) The output capacitor C_O is large enough that the output voltage can be treated as a constant DC voltage source.

B. Analytical Model

As shown in Fig. 4(a), the inductive WPT system can be represented by a simplified equivalent circuit. This model integrates an equivalent fundamental harmonic approximation voltage source, a practical transformer configuration, and the input impedance of the ZVDS Class-DE current-driven full-bridge rectifier. Based on this developed model, the actual transformer is characterized by its primary leakage inductance L_{lkP} , secondary leakage inductance L_{lkS} , and magnetizing inductance L_m . Following the derivations in [4], [9], the input impedance of the rectifier stage is denoted as $Z_{is} = R_i - jX_i$. For analysis, the equivalent AC load is treated as a series combination consisting of the input resistance R_i and the input reactance X_i , which is modeled via the input capacitance C_i as

$$R_i = \frac{4R'_L}{\pi f_s C_j (\pi + 2R'_L)^2}, \quad (1)$$

and

$$C_i = \frac{C_j}{\frac{\pi - 2R'_L}{(\pi + 2R'_L)^2} \sqrt{\frac{8\pi R'_L}{\pi^2} - \frac{1}{\pi} \cos^{-1}\left(\frac{\pi - 2R'_L}{\pi + 2R'_L}\right)}}. \quad (2)$$

where normalized load resistance is $R'_L = 2\pi f_s C_j V_O^2 / P_{out}$. By reflecting all secondary-side components to the primary side based on the turns ratio n , the equivalent circuit is transformed into the topology shown in Fig. 4(b). Furthermore, by expressing the transformer parameters through the coupling coefficient k , the primary self-inductance L_p and secondary self-inductance L_s are integrated into the simplified equivalent circuit of inductive WPT system as depicted in Fig. 4(c). In this representation, the combined secondary-side capacitance is defined as $C_{is} = C_i C_s / (C_i + C_s)$. When operating at the switching frequency, the inductive and capacitive reactances of the series-series resonant topology successfully cancel each other out $j0 \Omega$. Therefore, the overall network simplifies into the final equivalent circuit shown in Fig. 4(d), which directly accounts for the magnetizing current i_{Lm} with its associated magnetizing effects, and the input impedance looking from the output of the inverter stage obtained as $Z_{in} = nR_i + jX_m$.

3. STEADY STATE ANALYSIS

A. Improved Maximum Input Current of the Transmitter Compensation Network

The developed analytical model directly incorporates both the coupling coefficient and the magnetizing effects into the core equations, while fully accounting for the

behavior of the ZVDS Class-DE current-driven full-bridge rectifier shown in Fig. 4(d). By considering these critical parameters, the proposed approach ensures highly accurate input current of the transmitter compensation network and conduction loss calculations, successfully eliminating the estimation errors inherent in conventional methods. The average DC input current I_{DC} is evaluated by integrating the input current of the transmitter compensation network i_I over a half-cycle of the switching period is

$$I_{DC} = \frac{2}{T_S} \int_0^{T_S/2} I_I \sin\left(\frac{2\pi}{T_S}(t) - \theta\right) dt \quad (3)$$

$$= \frac{2}{\pi} I_I \cos \theta.$$

where the phase lag θ resulting from the magnetizing effects is derived from the relationship between the ZVDS Class-DE current-driven full-bridge rectifier input resistance R_i and the magnetizing reactance X_m is

$$\theta = \tan^{-1}\left(\frac{nR_i}{\omega_S L_m}\right). \quad (4)$$

Consequently, the system efficiency η of the proposed inductive WPT system is determined by relating the DC output power P_{out} to the DC input power P_{in} is

$$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{V_{DC} I_{DC}}. \quad (5)$$

By substituting (4) and (5) into (3) and rearranging the terms, the maximum input current of the transmitter compensation network I_I is

$$I_I = \frac{\pi P_{out}}{2\eta V_{DC} \cos\left(\tan^{-1}\left(\frac{nR_i}{\omega_S k L_P}\right)\right)}. \quad (6)$$

where $L_m = k L_P$. Therefore, the final analytical expression for the maximum input current of the transmitter compensation network I_I is presented as (6). This unified equation directly addresses the combined impacts of the coupling coefficient k , magnetizing inductance L_m , and the operational characteristics of the ZVDS Class-DE current-driven full-bridge rectifier regarding the maximum input current of the transmitter compensation network, thereby eliminating simplified approximations.

B. Improved Conduction Losses Calculation

Figure 5 shows the equivalent circuit of the proposed inductive WPT system for conduction loss analysis. The total conduction loss of the inductive WPT system consists of the following seven components: 1) the conduction loss of each MOSFET P_{rDS} , 2) the power loss of the primary resonant capacitor P_{rCP} , 3) the power loss of the primary self-inductor P_{rLP} , 4) the power loss of the

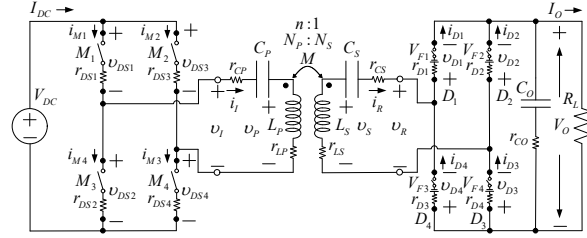


Fig.5: Equivalent circuit of proposed inductive WPT system for conduction loss analysis.

secondary self-inductor P_{rLS} , 5) the power loss of the secondary resonant capacitor P_{rCS} , 6) the conduction loss of each diode P_{rDB} , and 7) the power loss of the output capacitor P_{rCO} . Among these components, the conduction loss of each MOSFET, the power loss of the primary self-inductor L_P , and the power loss of the primary resonant capacitor C_P are the primary parts affected by the input current of the transmitter compensation network calculation. In the conventional model, these three losses are often miscalculated due to simplified current approximations. The specifications of the laboratory prototype are given in Table 1. By substituting (1) into (6), the maximum input current of the transmitter compensation network I_I is calculated by

$$I_I = \frac{\pi P_{out}}{2\eta V_{DC} \cos\left(\tan^{-1}\left(\frac{8nR_L}{\omega_S k L_P (\pi + 2\omega_S R_L C_j)^2}\right)\right)} \quad (8)$$

$$= \frac{\pi \times 1.8 \times 10^3}{2 \times 0.93 \times 360 \cos\left(\tan^{-1}\left(\frac{8 \times 1 \times 68.05}{2\pi \times 88 \times 10^3 \times 0.567 \times 176 \times 10^{-6} (\pi + 4\pi \times 88 \times 10^3 \times 68.05 \times 128 \times 10^{-9})^2}\right)\right)}$$

$$= 11.94 \text{ A.}$$

The four MOSFETs (M_1, M_2, M_3, M_4) in the on-state are modeled as switches with on-state resistances ($r_{DS1}, r_{DS2}, r_{DS3}, r_{DS4}$), respectively. In this work, the IXFN50N120SK (IXYS) MOSFET with r_{DS} of 50 m Ω is utilized. Based on the improved input current of the transmitter compensation network model, the conduction loss of each individual MOSFET P_{rDS} is determined by

$$P_{rDS} = \frac{I_I^2 r_{DS}}{4} \quad (9)$$

$$= \frac{11.94^2 \times 50 \times 10^{-3}}{4} = 1.78 \text{ W.}$$

Table 1: Laboratory Prototype Specifications

Parameter	Value
DC input voltage, V_{DC}	360 V
Output voltage, V_O	350 V
Maximum output power, P_{out}	1.8 kW
Switching frequency, f_s	88 kHz
Primary self-inductance, L_P	176 μ H
Secondary self-inductance, L_S	176 μ H
Resonant inductances, L_{lkP} , L_{lkS}	76 μ H
Mutual inductance, M	100 μ H
Coupled coefficient, k	0.567
Turns ratio, n	1
Primary resonant capacitance, C_P	43 nF
Secondary series capacitance, C_S	47 nF
Diode junction capacitance, C_j	128 pF
Output capacitance, C_O	10 μ F

The resistance r_{LP} represents the equivalent series resistance (ESR) of the primary self-inductor L_P of the loosely coupled transformer, where $r_{LP} = 670$ m Ω . By utilizing the improved input current of the transmitter compensation network, the power loss of the primary self-inductor P_{rLP} is obtained by

$$P_{rLP} = \frac{I_L^2 r_{LP}}{2} = \frac{11.94^2 \times 670 \times 10^{-3}}{2} = 47.76 \text{ W.} \quad (10)$$

The resistance r_{CP} represents the ESR of the primary resonant capacitor C_P , where $r_{CP} = 260$ m Ω . Based on the improved input current of the transmitter compensation network, the power loss of the primary resonant capacitor P_{rCP} is given by

$$P_{rCP} = \frac{I_L^2 r_{CP}}{2} = \frac{11.94^2 \times 260 \times 10^{-3}}{2} = 18.53 \text{ W.} \quad (11)$$

Consequently, considering only conduction losses calculated from the improved input current of the transmitter compensation network, the system efficiency η is obtained as

$$\begin{aligned} \eta &= \frac{P_{out}}{P_{out} + P_{losses}} \times 100\% \\ &= \frac{1,800}{1,800 + 130.28} \times 100\% \\ &= 93.25\%. \end{aligned} \quad (12)$$

where $P_{losses} = 4P_{rDS} + P_{rCP} + P_{rLP} + P_{rLS} + P_{rCS} + 4P_{rDB} + P_{rCO}$. Under the high-power operating conditions of the proposed inductive WPT system, the fundamental conduction losses from the ESR of L_P and L_S are significantly higher than the losses caused by skin and proximity effects. Therefore, skin and proximity effects are neglected to simplify the mathematical model without compromising overall calculation accuracy.

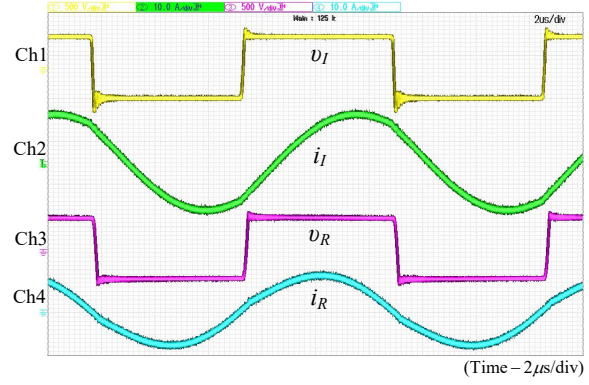


Fig.6: Experimental waveforms of input voltage v_I and input current i_I of transmitter compensation network, and input voltage v_R and input current i_R of ZVDS Class-DE current-driven full-bridge rectifier waveforms at $P_{out} = 1.8$ kW.

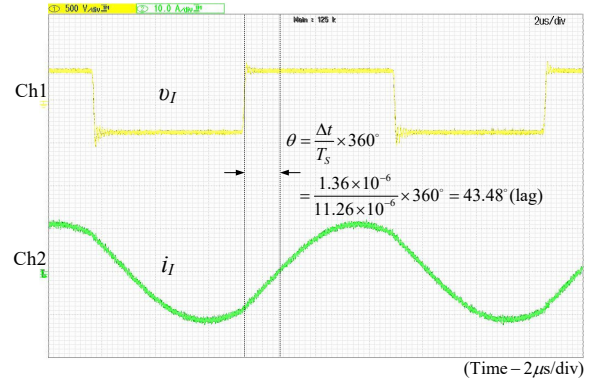


Fig.7: Experimental waveforms of input voltage v_I and input current i_I of transmitter compensation network at $P_{out} = 1.8$ kW.

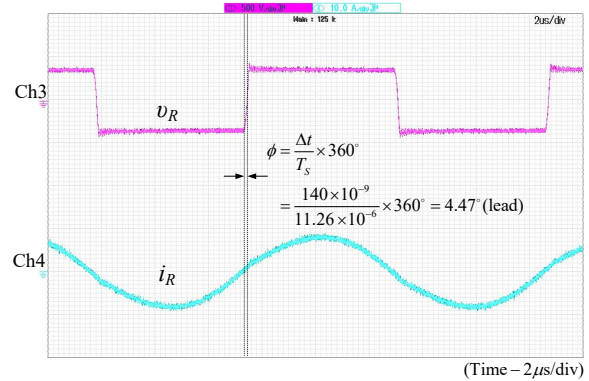


Fig.8: Experimental waveforms of input voltage v_R and input current i_R of ZVDS Class-DE current-driven full-bridge rectifier waveforms at $P_{out} = 1.8$ kW.

4. EXPERIMENTAL RESULTS AND DISCUSSION

To validate the accuracy of the proposed model, a laboratory prototype of the inductive WPT system was constructed. This section presents a comparative analysis

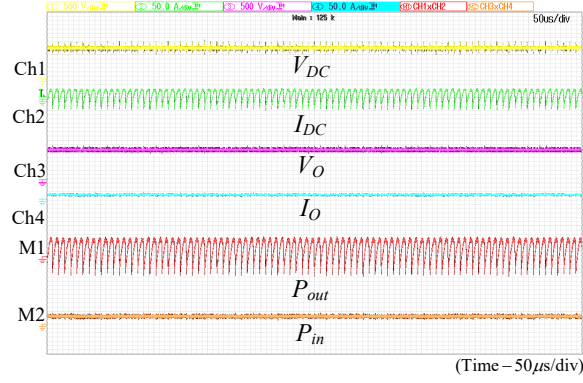


Fig. 9: Experimental input voltage V_{DC} , input current I_{DC} , output voltage V_O , output current I_O , input power P_{in} , and output power P_{out} waveforms at $P_{out} = 1.8$ kW.

Table 2: Parameter Values and Calculation Errors of Both Models

Parameter	Conventional Model	Proposed Model	Experimental Results	Error of Conventional Model	Error of Proposed Model
I_I	8.44 A	11.94 A	12.2 A	30.82%	2.13%
P_{losses}	93.56 W	130.28 W	134 W	30.18%	2.78%
η	95.06%	93.25%	93.38%	1.8%	0.14%

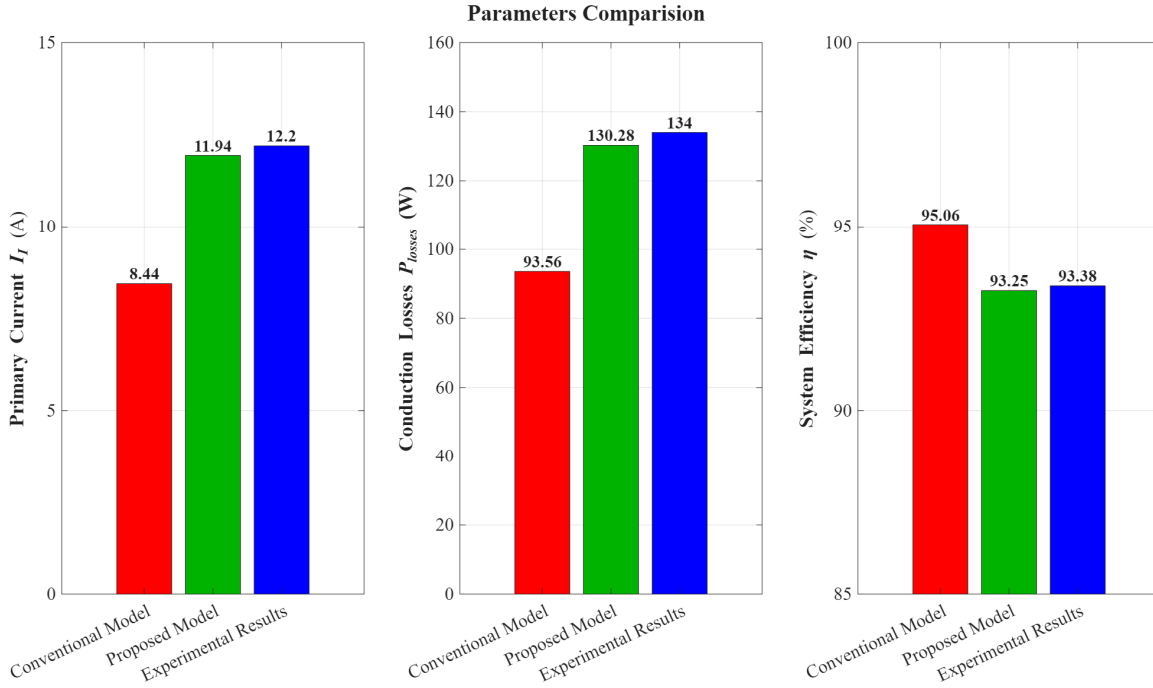


Fig. 10: Comparison of key parameters and calculation errors.

between the theoretical calculations of the conventional model, the proposed model, and the actual experimental results. Figure 6 shows the experimental waveforms of the input voltage v_I and input current i_I of the transmitter compensation network, as well as the input voltage v_R and input current i_R of the ZVDS Class-DE current-driven full-bridge rectifier at an output power $P_{out} = 1.8$ kW.

Figure 7 shows the experimental waveforms of the input voltage v_I and the input current i_I of the transmitter compensation network at $P_{out} = 1.8$ kW. Under the proposed inductive WPT system model, the calculated maximum value of the input current of the transmitter compensation network i_I is 11.91 A, which closely matches the measured experimental peak current of 12.2 A with a

minimal error of only 2.13%. In contrast, the conventional model in [4], [9] yields a calculated current of 8.44 A, resulting in a severe underestimation with a significant error of 30.82%. This large discrepancy occurs because the conventional model neglected the magnetizing effects and the large phase lag. Specifically, the proposed model calculated a phase lag of 44.84° , which tightly matched the experimentally measured phase lag of 43.48° caused by the high magnetizing current under loose coupling conditions.

Figure 8 presents the experimental waveforms of the input voltage v_R and the input current i_R of the ZVDS Class-DE current-driven full-bridge rectifier at $P_{out} = 1.8$ kW. It can be seen that the input current i_R is nearly in phase with the input voltage v_R , exhibiting a minimal phase lead of only 4.47° . This near-in-phase characteristic confirms that the rectifier successfully operates under the ZVDS condition. Therefore, the reactive power within the receiver side is minimized, which effectively reduces switching losses and validates the high-efficiency operation predicted by the proposed model.

The measured waveforms of the DC input voltage V_{DC} , input current I_{DC} , output voltage V_O , output current I_O , input power P_{in} , and output power P_{out} are displayed in Fig. 9. The system operates with an input power P_{in} of 1.934 kW and delivers an output power P_{out} of 1.8 kW. Based on these experimental measurements, the overall system efficiency η of the proposed inductive WPT system reaches 93.38%.

The key parameters calculated from both models and the actual experimental results are compared in Table 2 and Fig. 10, respectively. The conventional model showed large calculation errors of 30.82% for the input current of the transmitter compensation network and 30.18% for the conduction losses. In contrast, the proposed model significantly reduced these errors to only 2.13% and 2.78%, respectively. Furthermore, the efficiency error of the proposed model was extremely low at just 0.14%, compared to 1.80% of the conventional model, which confirmed its high accuracy.

Moreover, the frequency segmentation problem is effectively eliminated in the proposed model for WPT system through the precise tuning of the compensation network and system impedance parameters. Under the targeted operating frequency, the primary-side compensation and ZVDS Class-DE current-driven full-bridge rectifier loading maintain a smooth, single-peak voltage gain profile while preserving a stable inductive input impedance angle. By ensuring that the system operates strictly within this optimized region, multiple resonant zero-phase angle crossings are avoided, thereby preventing frequency splitting and guaranteeing stable power transfer performance.

5. CONCLUSION

In this paper, the proposed inductive WPT system model with a ZVDS Class-DE current-driven full-bridge rectifier has been successfully developed for accurate conduction loss analysis. It was demonstrated that conventional models assuming a near-infinite magnetizing

inductance failed in applications where a low magnetizing inductance induces a very high magnetizing current. This elevated magnetizing current causes a significant phase lag of the input current relative to the input voltage of the transmitter compensation network, leading to substantial reactive power and increased conduction losses. By including the coupling coefficient and these magnetizing effects into the key equations, the proposed inductive WPT system model overcomes these limitations.

Experimental validation on the developed inductive WPT converter utilizing a phase-shift controller at an 88-kHz switching frequency operating under a 360-V input voltage and a 350-V output voltage confirms the accuracy of the proposed model across an output power range from 0.2 kW to 1.8 kW at a 50-mm transfer distance. Specifically, while the conventional model showed a lower input current of 8.44 A, which miscalculated the input current by 30.82%, the conduction losses by 30.18%, and the efficiency by 1.80% at 95.06%, the proposed model achieved a highly accurate current calculation of 11.91 A and an accurate efficiency of 93.27%. This closely matched the experimental results of 12.2 A and 93.38%, respectively, restricting the current and efficiency calculation errors to just 2.13% and 0.14%, demonstrating the validity of the proposed analytical model.

6. ACKNOWLEDGEMENT

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7. REFERENCES

- [1] J. Thongpron, W. Tammawan, T. Somsak, W. Tippachon, K. Oranpiroj, E. Chaidee, and A. Namin, "A 10 kW Inductive Wireless Power Transfer Prototype for EV Charging in Thailand," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 20, no. 1, pp. 83-95, Feb. 2022.
- [2] Y. Yang, "Precise Modeling of Nonlinear Rectifier Loads in Wireless Power Transfer Systems," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 11, no. 3, pp. 3574-3585, Jun. 2023.
- [3] F. Xu and H. Huang, "Frequency Selection for Underwater Wireless Power Transfer based on the Analysis of Eddy Current Loss," *AEU - International Journal of Electronics and Communications*, 2023; 163:154168.
- [4] S. Feungkeaw, C. Ekkaravarodome, K. Jirasereamornkul, and Y. Kumsuwan, "Analysis of a ZVDS Class-DE Current-Driven Full-Bridge Rectifier to Compensation Network Capacitance Design for WPT System," in *21st International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*, Khonkaen, Thailand, 2024.

- [5] Y. Komiyama, A. Komanaka, W. Zhu, A. Konishi, K. Nguyen, and H. Sekiya, "Analysis and Design of Load-Independent Series Resonant Power Amplifier With Constant Current Output and Its Application for WPT System," *IEEE Transactions on Power Electronics*, vol. 39, no. 5, pp. 6515-6525, May 2024.
- [6] M. Venkatesan, R. Narayanamoorthi, K. M. AboRas and A. Emara, "Efficient Bidirectional Wireless Power Transfer System Control Using Dual Phase Shift PWM Technique for Electric Vehicle Applications," *IEEE Access*, vol. 12, pp. 27739-27755, Feb. 2024.
- [7] Y. Jia, L. Zhao, Z. Wang, C. Tang, F. Chen, and H. Feng, "Integrated LCC-LCC Topology for WPT System with CC Output Regarding Air Gap and Load Variations," *IEEE Transactions on Power Electronics*, vol. 12, no. 1, pp. 11904-11915, Oct. 2024.
- [8] L. Yang, S. Jiang, C. Wang, Y. Shi, M. Wang, C. Cai, and L. Zhang, "A High-Efficiency Integrated LCC/S WPT System With Constant Current Output," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 12, no. 1, pp. 341-354, Feb. 2024.
- [9] C. Ekkaravarodome, S. Feungkeaw, A. Bilsalam, K. Jirasereamornkul, and Y. Kumsuwan, "Analysis of a ZVDS Class-DE Current-Driven Full-Bridge Rectifier to Compensation Network Capacitance Design for WPT System," *AEU - International Journal of Electronics and Communications*, 2025; 191:155660.
- [10] Y. Sabyrov, Z. Kudaibergenova, and M. Hashmi, "Employing a Novel Partitioning Approach for the Power Transfer Efficiency Enhancement of Near-Field Planar WPT System," *AEU - International Journal of Electronics and Communications*, 2025; 192:155714.
- [11] S. Yousawat, E. Chaidee, W. Tammawan, T. Sriprom, W. Muangjai, N. Phutcharaprakiti, J. Thongpron, A. Namin, "Experimental Validation of Standards Compliant Inductive Wireless EV Charging Station with Misalignments and Installation Dependent Performance," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 23, no. 3, Oct. 2025.
- [12] X. Lv, X. Dai, F. Yu, X. Li, H. Wang, Y. Sun, and J. Hu, "A High Misalignment Tolerance SCC-WPT System With Relay Single Capacitive Coupler for UAV Wireless Charging Applications," *IEEE Transactions on Power Electronics*, vol. 40, no. 8, pp. 10372-10377, Aug. 2025.
- [13] A. Lai, D. Zhou, F. Li, Z. Shen, J. Zou, and X. Liu, "A Series-Parallel Inverter-Based WPT System for Electric Vehicles With Different Input Voltages and Z Classes," *IEEE Transactions on Power Electronics*, vol. 40, no. 6, pp. 8847-8858, Jun. 2025.
- [14] X. Fan, S. Xu, W. Huang, R. Zhong, and X. Zhang, "Tunable T-type Network Parameters Determination Method Based on Improved Beluga Whale Optimization for a MHz WPT System's Adaptive Impedance Matching," *AEU - International Journal of Electronics and Communications*, 2026; 204:156091.
- [15] L. Ji, J. Zhang, and M. Zhang, "Reconfigurable Topology Design for WPT Systems With Constant Power Output Characteristics," *IEEE Transactions on Power Electronics*, vol. 41, no. 1, pp. 1329-1339, Jan. 2026.
- [16] X. Liu, S. Bian, A. Ma, C. Rong, and C. Xia, "Research on CV/CC Charging Modes Along With Power Distribution in a Dual-Load MCR-WPT System Based on Phase Shift Control Strategy," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 14, no. 2, pp. 2253-2264, Apr. 2026.
- [17] F. Xu, Y. Ren, M. Xue, Z. Chen, X. Zhang, J. Liu, and F. D. Wijaya, "Constant Power Output for LCC-LCC Compensated WPT Systems Considering Large Variations of Loads and Coupling Coefficients," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 14, no. 2, pp. 2565-2573, Apr. 2026.
- [18] X. Liu, T. Zhao, D. Jin, and C. Xia, "Parameter Identification and Power-Efficiency Optimization Strategy for LCC-LCC/S WPT System Based on Controllable Switching Devices," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 14, no. 2, pp. 2683-2694, Apr. 2026.
- [19] C. Ekkaravarodome and K. Jirasereamornkul, "Analysis and Implementation of a Half Bridge Class-DE Rectifier for Front-End ZVS Push-Pull Resonant Converters," *Journal of Power Electronics*, vol. 13, no. 4, pp. 626-635, Jul. 2013.
- [20] M. Vesali and M. Delshad, "A Nonisolated Bidirectional ZVS Converter for Low Power Application," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 14, no. 2, pp. 26-34, Aug. 2016.
- [21] R. B. Darla and A. Chitra "Performance Comparison Analysis of a High Voltage DC LLC Resonant Converter for Telecom and Datacenter Applications," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 21, no. 1, Feb. 2023.
- [22] M. Vesali, M. Khorami, and F. Ghafoorian, "A New Zero Voltage Switching Bidirectional DC-DC Converter with Simple Structure," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 21, no. 2, Jun. 2023.
- [23] M. Vesali, "A New High Step-Up Single Switch DC-DC Converter with Soft Switching on All Semiconductor Elements," *ECTI Transactions on Electrical Engineering, Electronics, and Communications*, vol. 22, no. 2, Jun. 2024.