Dynamic Wireless Power Transfer Device Charging Application for Electric Vehicle

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ABSTRACT

In an attempt to cut pollution, the public and private transportation sectors have altered their views on electric cars (EVs). The battery issue is the primary and most important barrier to the commercialisation and broad adoption of electric cars. The most difficult part of designing an electric car is the battery as it must to simultaneously satisfy several specifications, such safety, great power and energy density, and acceptable price, lifespan, or dependability. The battery has a short lifespan, is heavy, expensive, and huge. Continuous charging and short operating times due to low energy density are further obstacles to the worldwide growth of EVs. Dynamic wireless energy transfer is one practical way to lessen battery problems. This Power Transfer via Dynamic Wireless method allows battery of an electric vehicle (EV) that can be charged while moving. People may be able to break free from the constraints of heavy cables thanks to a method known as dynamic wireless power transmission (DWPT), which uses magnetic resonance. In actuality, the inductive electrical switch, which has been in use for at least 40 years, and the idea behind wireless energy transmission is the same. Within a dynamic wireless power transfer, The coils of the transmission are grounded and reception the coil is installed. below An electric car. It is possible to considerably lower the size of the electric car's batteries and enhance its operating range by providing a suitable charging infrastructure that can support the vehicle while it is moving.
Key Words: Transmission coils, inductive electricity, magnetic resonance, electric vehicles (EVs), and dynamic wireless power transfer (DWPT).

INTRODUCTION

The environmental situation is currently becoming worse and there is a depletion of mineral resources. The electrical installation in the vehicle has been completed for a variety of reasons, including energy and environmental concerns. The linked kind of electric charger that is used nowadays can be found at work, home, or central charging stations. However, there are frequent disruptions and simple electrical leakage when using the linked charger.
Electric vehicles (EVs) may be charged using a variety of chargers with varying power outputs.
Electric vehicles (EVs) may typically be charged at home during off-peak hours using a level 1 charger. This kind of charger works with the household electric outlet and is sluggish charging. A level 2 charger, which is semi-fast and available in most places, can supply sufficient power. The most common way to charge electric cars (EVs), both private and public, is with a Level 2 charger. Typically, single-phase chargers are used for both level 1 and level 2 charging. Electric vehicles are massively charged using the level 3 charger, often known as the high power rapid charger. The primary applications for these chargers are in the public and commercial sectors, and they are typically three phase chargers. One of the most popular and important areas of study in transportation technology is wireless power that is dynamic transmission. For electric car, especially the system for Dynamic Wireless Power Transmission has drawn focus for its ability as an significantly reduce battery size and boost driving distance. It is now feasible to transport electricity wirelessly and without the need of any kind of cable between a source (transmitter) and a receiver thanks to wireless power transfer. Wireless charging systems provide a number of benefits over traditional charging systems, including simplicity, ease of use, safety, and realism.

ELECTRICAL VEHICLE WIRELESS CHARGING

Based on how they work, wireless chargers for electric vehicles may be divided into three primary categories:
1. Wireless power transmission that is static 2. Wireless power transmission that is dynamic

3. Wireless power transfer that is quasi-dynamic.

When the electrical car is positioned over the charging station in a parked lot, the battery charges via static wireless power transmission. Dynamic Wireless Power Transfer (DWPT) charging is the second kind of wireless charging. Under this sort of charging arrangement, the electric car charges while it is moving, extending its cruising range (EV). Another kind of charging system that operates somewhere in between static and dynamic charging methods is called quasi-dynamic wireless power transmission. Equipped with wireless chargers, the electric car travels and then stops at a certain location.

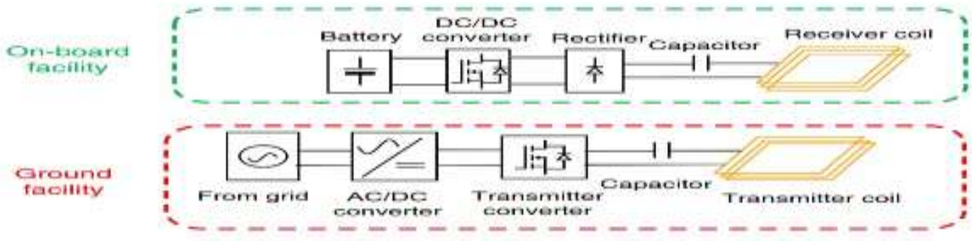


Fig. 1. Wireless charging system's basic circuit

There are two components to the charging setup: the onboard component and the ground facility. The transmitter, converter, transmitter coil, and reimbursement network make up the ground facility. The rectifier, compensation network, receiver coil, and DC to DC converter, and battery make up the onboard component. A wireless power transmission that is dynamic system's circuit layout is in different topology:

1. Segmented Track Topology
2. Long Track Topology.

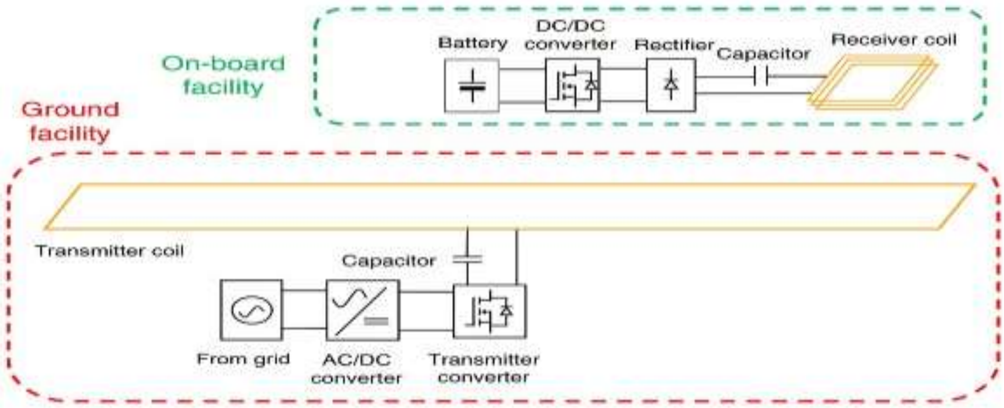


Fig.2. Long track topology dynamic WPT.

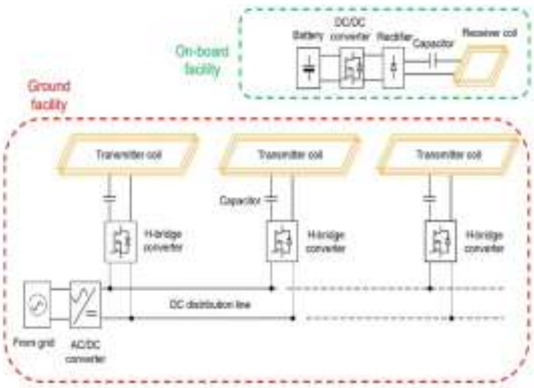


Fig.3. Segmented track topology in dynamic WPT

A SYNOPSIS AND ANALYSIS OF WPT

Currently, universities and businesses worldwide are conducting a great deal of research on dynamic wireless power transfer, or DWPT. As a result of these diligent efforts, several solutions have been developed, published in literature, and some have even been used in real-world situations for a range of purposes. as rail transportation, light-weight vehicles, and public buses.

EXAMINING THE CIRCUIT

Through magnetic resonance coupling, capacitors are used to adjust the transmitter and receiver coils for effective and resilient wireless power transmission in the event of misalignment. Figure 4 illustrates the usage of a series-series compensation arrangement with its corresponding circuit. As seen in Figure 4, the internal resistances R1 and R2, the series capacitances C1 and C2, and the inductances L1 and L2 define the characteristics of the transmitter and receiver coil.

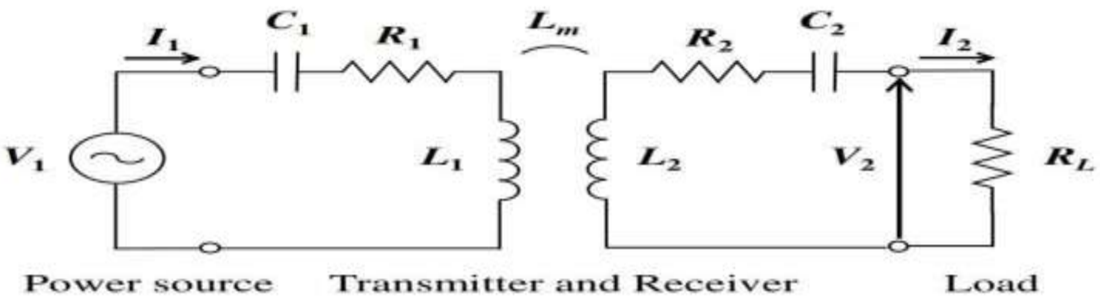


Fig. 4 Wireless power system equivalent circuit

Table 1 Parameters of coils

Parameter	Value	Unit
Resistance R1, R2	0.75,0.50	Ohm
Inductance L1, L2	260, 110	μH
Capacitance C1, C2	12.3, 28.2	nF
Operating Frequency	84	kHz
Mutual Inductance Lm	14.2	μH

In Table 2, the parameters are displayed. Let Lmbe the coils' mutual inductance. If the source power's angular frequency is such that:

$\omega 0=1\sqrt{L1C1} = 1\sqrt{L2C2}$

Then, the transmitting efficiency, $\eta$is given by:

$$\eta= (\omega 0Lm)2RL(R1+R2)\{R1R2+R1RL+(\omega 0Lm)2\}$$

& the transmitting power, P can be calculated as:

$$P= (\omega 0Lm)2Rl\{R1R2+R1RL+(\omega 0Lm)2\}2\ V12$$

where R_L is The load resistance and V_1 is the primary voltage's RMS values. To improve gearbox efficiency, R_L must be provided as

$$RL\eta max \quad R2\{(\omega 0Lm)2R1+R2\}$$

CIRCUIT OF SIMULATION AND OUTCOMES

Figure 5 shows the Wireless Power Transfer System prototype's simulated power circuit. The H-Bridge conversion uses the IGBT switches. The receiver In charge is intended to regulate receiver's output power, while the transmission command is intended to restrict the transmission current under misaligned conditions. Although they are not in contact with one another, the transmitter and receiver controls cooperate.

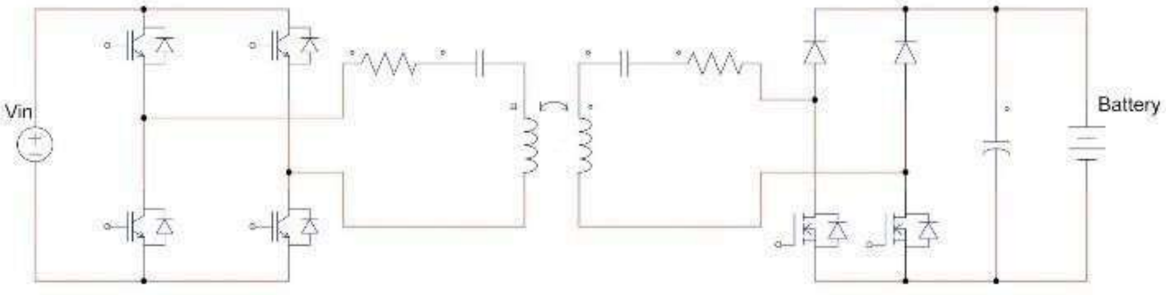
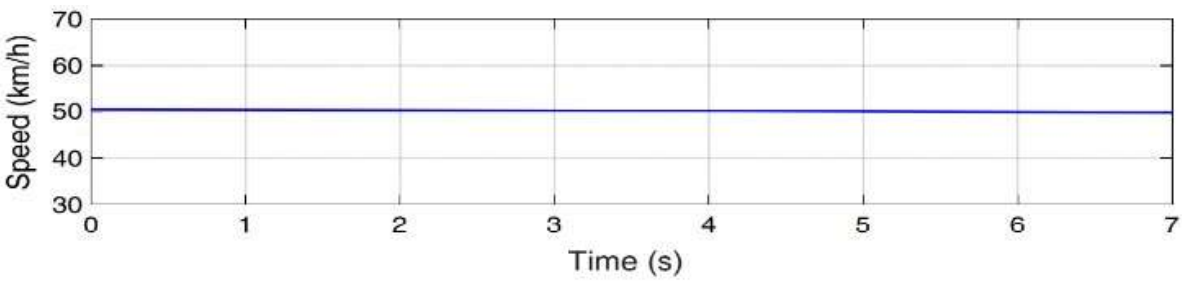
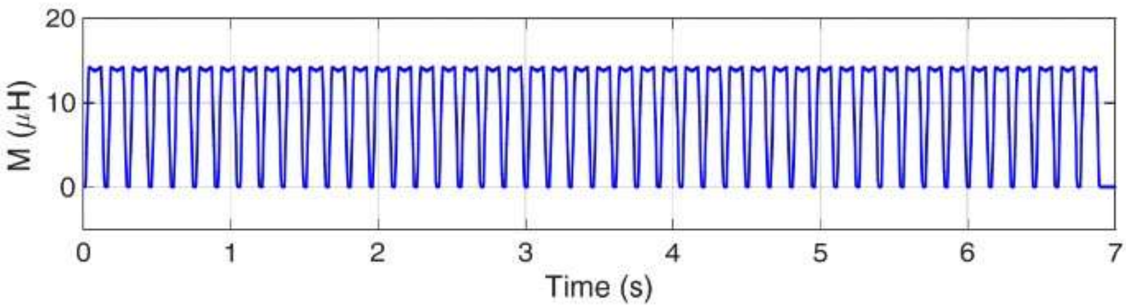


Figure5:Configuration of the power circuit

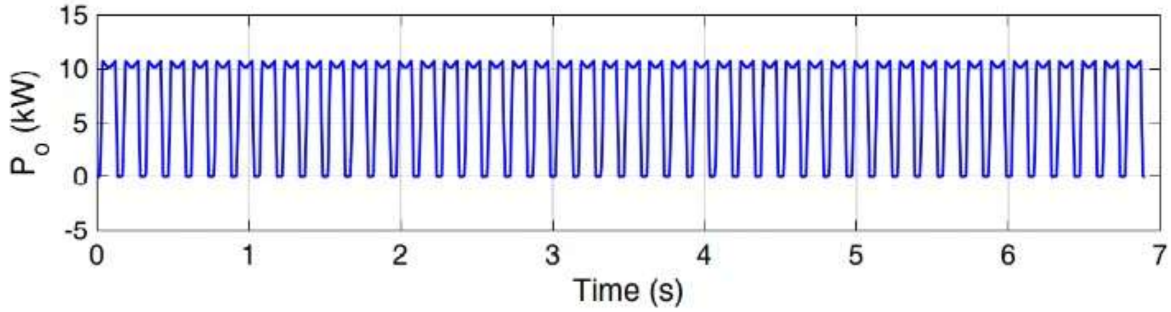
The simulation assesses the performance at various parameter frequencies, resistances, and misalignmentcircumstance.



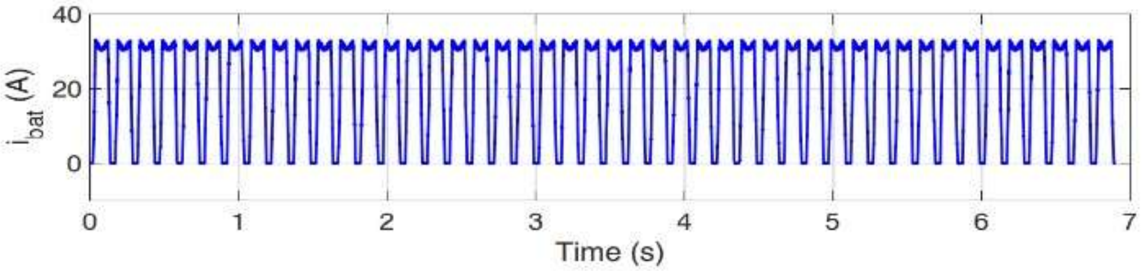
(1)



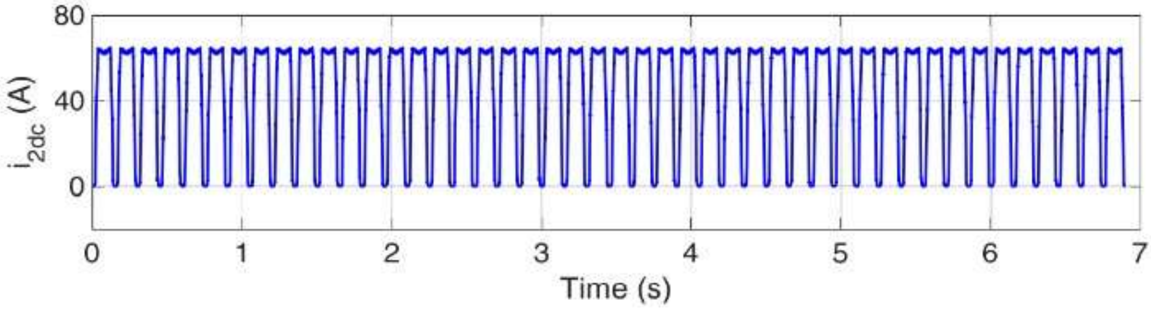
(2)


15
10
5
0
-5
P$_o$ (kW)
0
1
2
3
4
5
6
7
Time (s)

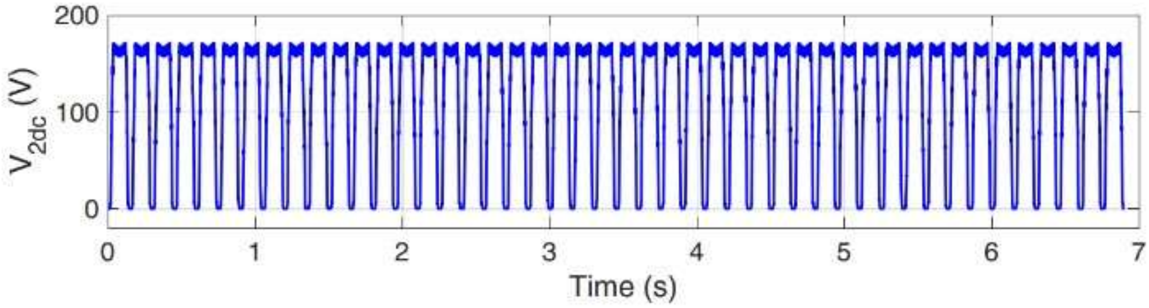
(3)


40
20
0
i$_{bat}$ (A)
0
1
2
3
4
5
6
7
Time (s)

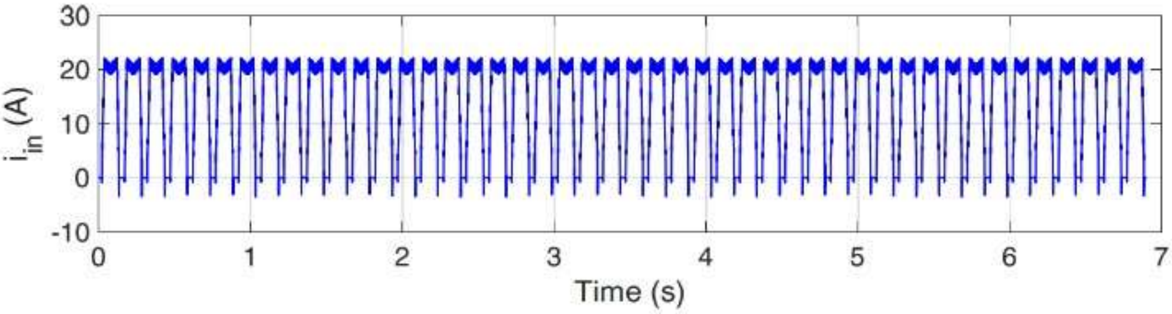
(4)


80
40
0
i$_{2dc}$ (A)
0
1
2
3
4
5
6
7
Time (s)

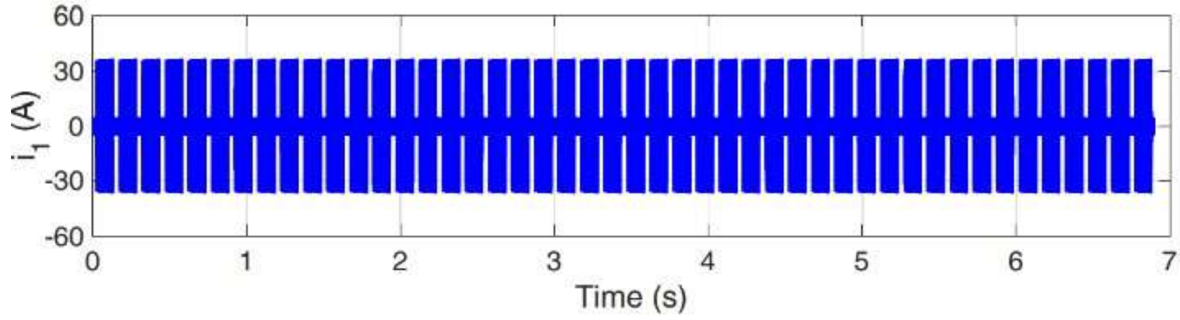
(5)

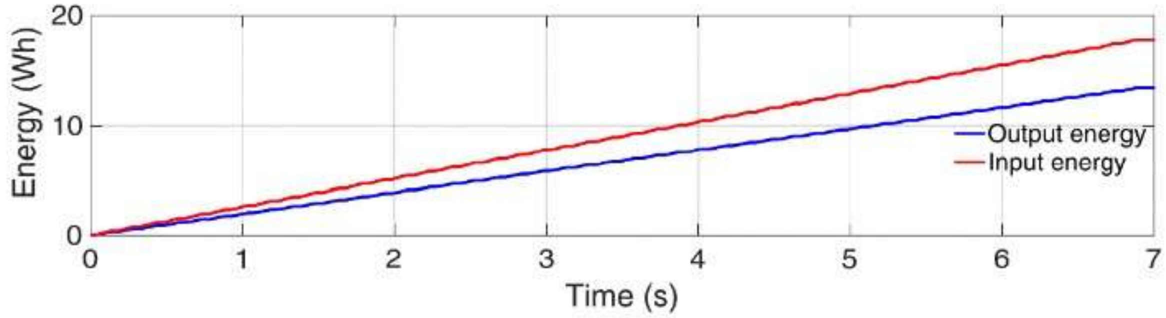

200
100
0
V$_{2dc}$ (V)
0
1
2
3
4
5
6
7
Time (s)

(6)


30
20
10
0
-10
i$_{in}$ (A)
0
1
2
3
4
5
6
7
Time (s)

(7)

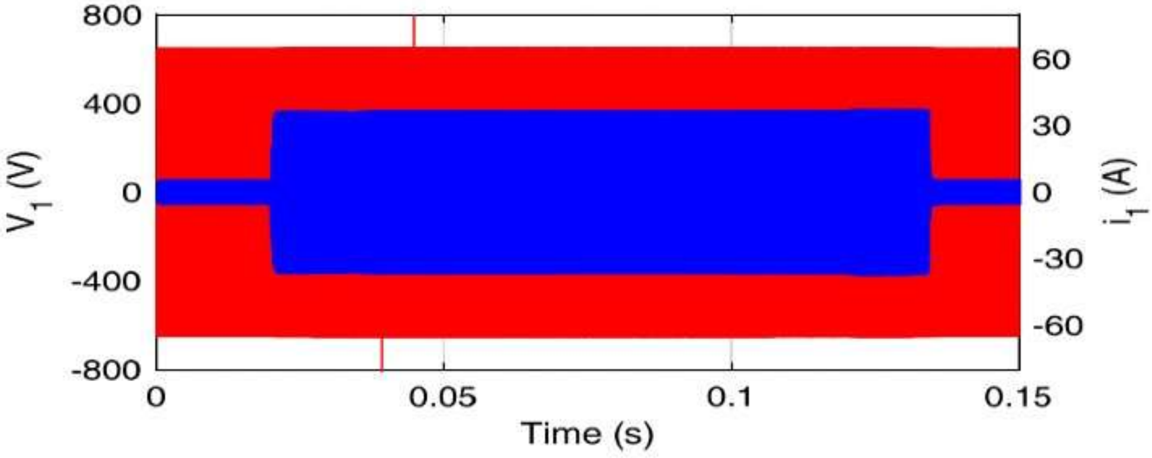




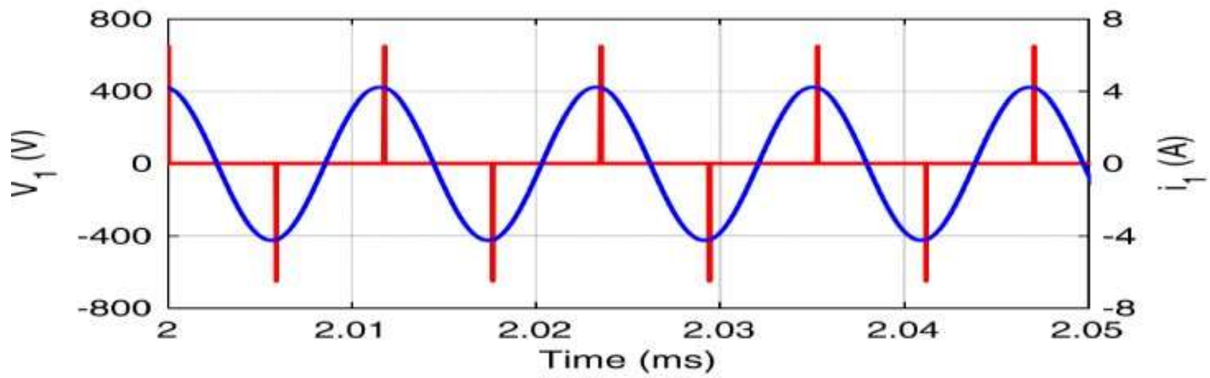
(8)

(9)

Various system values during dynamic charging are shown in Fig. 8. Vehicle speed, mutual inductance, battery power received, battery current, receiver DC current, receiver DC voltage, input DC source current, transmitter current, and (9) battery energy received during the charging process are all included in this list. Figure 9 displays the transmitter's voltage and current waveforms.



(1)



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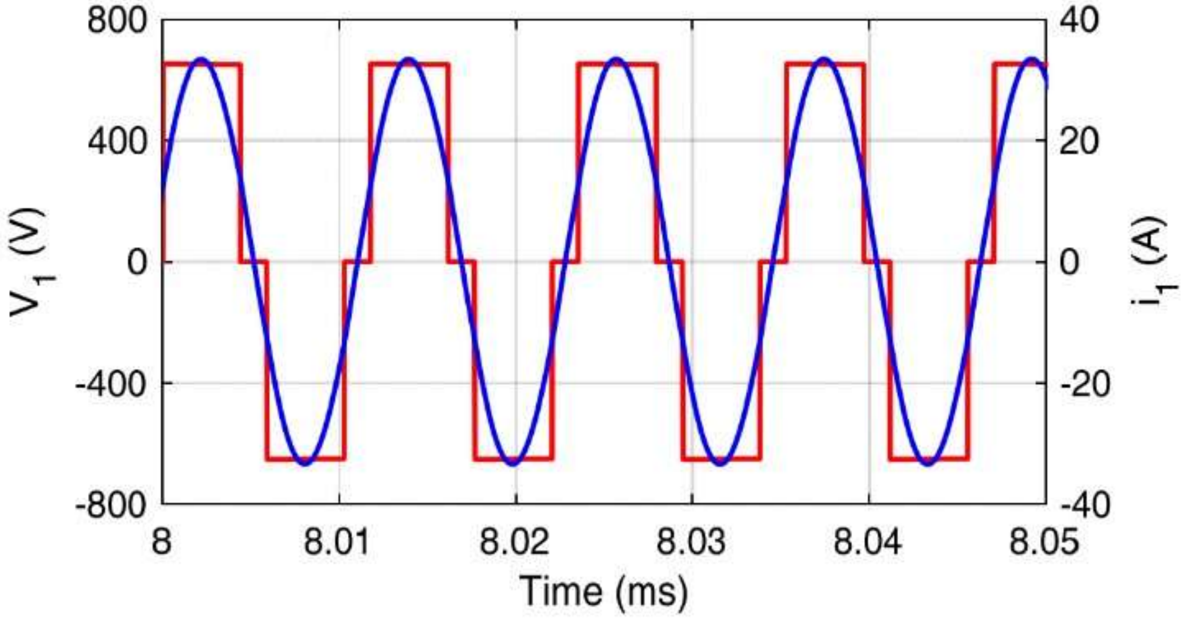

(3)

Figure 9. Transmission current or voltage 50 km/h. (a) while the car is moving, (b) while it is being identified, and (c) while power is being transferred.

CONCLUSION

The Power Transfer via Dynamic Wireless method for EV Energising is examined with in the research. The system that was planned was modelled. The system's performance was examined in both static and dynamic circumstances. It was shown how the system behaved under static conditions at various parameters such as mutual inductance and operating frequency. Additionally, an assessment was conducted on the charging system's performance under various circumstances, including changes during the air-gap, speed of vehicle, and Sideways misalignment, throughout the Power Transfer via Dynamic Wireless. An efficiency of 79.1 was attained at a speed of 60 km/h and nominal air-gap.

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