Analysis of 10 Watt and 15 Watt Universal Wireless Charger

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Abstract—**Wireless power transfer (WPT) has emerged as a practical alternative to conventional cable-based smartphone charging systems, particularly following the commercialization of inductive wireless charging technology. This paper presents a comparative analysis of the electrical and operational characteristics of 10 W and 15 W universal wireless charger primary-side devices commercially available on the market. The analysis focuses on operating frequency, peak-to-peak voltage, effective charging distance, and battery charging performance using an identical receiver module. Experimental results indicate that the 10 W primary-side device operates within a frequency range of 111–128 kHz, producing a peak-to-peak voltage of 19–26 V with a maximum effective charging distance of 12 mm and an average charging duration of 56.39 min per 10% battery increment from 0% to 100%. Meanwhile, the 15 W device exhibits a higher operating frequency range of 118–160 kHz, generates a peak-to-peak voltage of 16–24 V, and achieves an effective charging distance of up to 14 mm, with an average charging time of 68.50 min per 10%. Both systems utilize toroidal primary coils with distinct geometric dimensions and inductance values, which significantly influence power transfer characteristics. Furthermore, under load conditions, both primary-side devices experience an increase in peak-to-peak voltage accompanied by a reduction in operating frequency.**

Keywords— Induction, Power Transfer System, Resonant Coupling, Universal Wireless Charging, Wireless Power Transfer.

I. INTRODUCTION

Electrical energy is included as a primary need that is very necessary for humans in everyday life. Many activities carried out by humans require electrical energy, as it is known that electrical energy is needed to carry out household activities such as lighting and electronic devices, including charging smartphones. However, when the cellphone's battery starts to run out, the device needs to be recharged so that it can be used again, and current charging technology still uses a connecting cable. So, with the development of science and technology which is increasingly advanced and full of innovation, it currently provides many conveniences and benefits for humans, especially in the field of electrical industry and one example of the development of electronic devices is wireless power transfer [1]-[5].

Wireless power transfer is a type of electrical energy that is transmitted through air, without using cables, which makes it easy for users of electronic devices to transmit charging to reduce the risk of electric shock or short circuit. Where the working principle is not much different from a transformer which uses the principle of inductance which arises due to the magnetic field created by an electric current. so that in a transformer the size of the magnetic field formed depends on several factors, namely the core metal material, winding material and the number of conductor turns [6]-[10].

Wireless power transfer (WPT) technology has developed rapidly due to industrial advances and modern technology so that it is widely used in various fields, such as portable electronic devices, radio players, biomedical equipment, aerospace, electronics, manufacturing facilities, unmanned aerial vehicles. (UAV), electric vehicles and so on. Precisely in 2014, many leading smartphone manufacturers, such as Samsung, Apple, and Huawei, began releasing new generation devices equipped with wireless charging capabilities using the induction principle.

Despite the advantages which are considered quite large, there are still problems behind this wireless charging technology. One of the problems that still cannot be resolved is the transfer distance and the amount of voltage that can be transferred using wireless charging technology, so engineers who have carried out research on this technology are still have not yet found a significant solution regarding the problem of distance and the amount of voltage transfer that can be carried out, and for example, based on several studies that have been carried out, the distance that can be covered by the oscillation process in the wireless charging process is still not said to be good [11]-[15].

This research will focus on analyzing the differences in characteristics of primary side devices that have 10 watts and 15 watts of power but use universal wireless charging on the market. In this research, we will focus on the frequency and peak-to-peak voltage values produced, so that later we can find out whether the input or output issued on the primary side device has different specifications but with the same receiver.

II. METHOD

In this study using quantitative methods. Where this study uses data results in the form of numbers or pictures of experimental results in collecting data. The data obtained from universal wireless charging measurements will be analyzed according to existing theory so that later the data obtained will be adjusted to the measurement parameters to obtain the analysis results and final conclusions. The data sampling plan using an oscilloscope will be explained in Fig 1

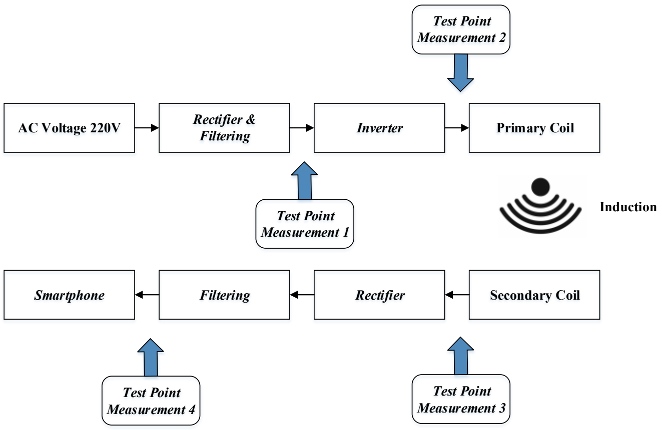

Figure 1. Diagram of the point where the measurement of the wireless charging system will be carried out

In Fig. 1 is an image of the planning point (test point) that will be used to make measurements using an oscilloscope. For the first measurement test point, it is at the DC output from the 5V cellphone charger or it could also be at the USB input on the side of the primary device. The second test point is on the primary winding coil which has gone through an inverter circuit so that the AC voltage produced can be known. The third is on the receiving side, namely on the secondary coil which is induced from the primary coil on the primary side so that the AC voltage received from the primary coil can be known. The final test point is in the power output section of the wireless charging receiver or that leads to the cellphone USB to find out the voltage output that can be transferred to charge the cellphone battery.

In this experiment Fig. 2, there are several test parameters that will be analyzed in this study, namely:

1. Frequency results, input & output voltage, peak-to-peak produced without cellphone / smartphone load
2. Frequency results, input & output voltage, peak-to-peak produced when a cellphone/smartphone is loaded
3. Influence of distance & speed on charging time

Figure 2. Current image of the measurement experiment device

III. RESULTS AND DISCUSSION

A. Results when there is & is not a load on the 10 watt Universal Wireless Charger device

The block diagram of measuring DC input at test point 1 and DC output on the secondary side at test point 4 shown in the Fig. 3.

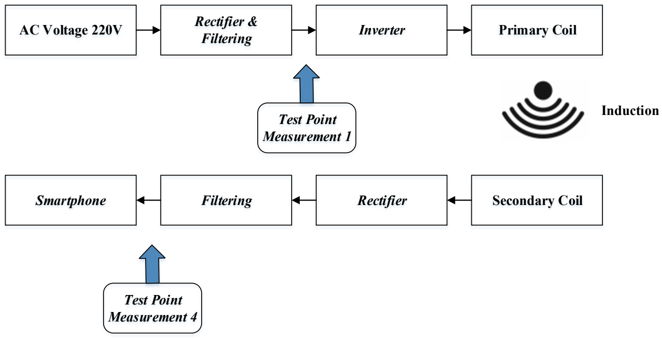

Figure 3. Block diagram of measuring primary side input and secondary side output

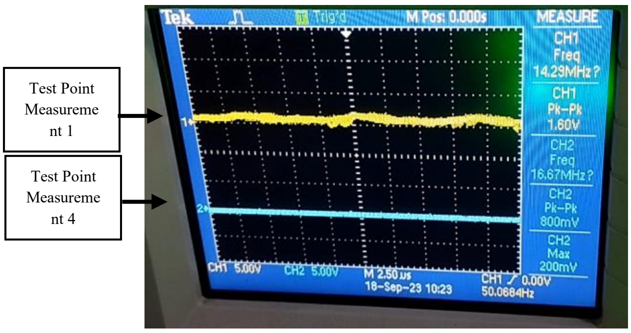

Figure 4. Results of oscilloscope measurements DC input & DC output

Fig. 4 shows the results of the voltage entering the primary side when there is no load are shown in oscilloscope Fig.4 test point 1, namely 1.60v with a working frequency of 14.29 MHz, here the resulting voltage is not yet optimal because there is no load so the power distribution is not optimal, as are the results The resulting frequency wave is not regular so there is still a little negative polarity coming in, while the DC output results which are shown in the oscilloscope Fig. 4 test point 4 produce a frequency of 16.67 MHz with wave results that are even and more regular, for peak-to voltage. The resulting peak is very small, namely 800 mv.

Fig. 5 shows that the results of the voltage entering the primary side when the cell phone has been loaded on the secondary side has experienced a slight increase compared to when it has not been loaded as shown in Figure 5 test point 1, namely 2.20V with a working frequency of 25 MHz with the form sine wave but is still relatively small, whereas for the dc output voltage results shown in Figure 5 test point 4, the resulting peak-to-peak voltage value remains the same, namely 800 mV and has an increase in frequency compared to when the cellphone was not loaded, namely 33.33 MHz with wave results that are more or less the same as when there was no load, namely flat and more regular.

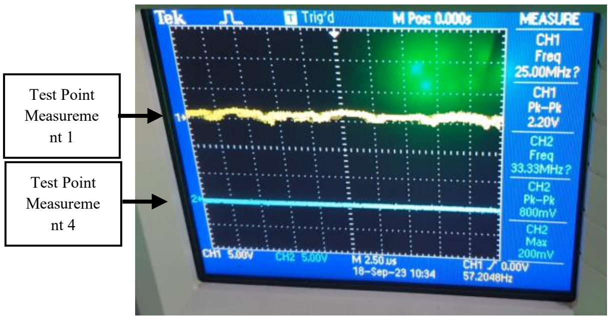

Figure 5. Results of oscilloscope measurements dc input & dc output when there is a load

The block diagram of measuring AC input at test point 2 and AC output on the secondary side at test point 3 shown in the Figure 6.

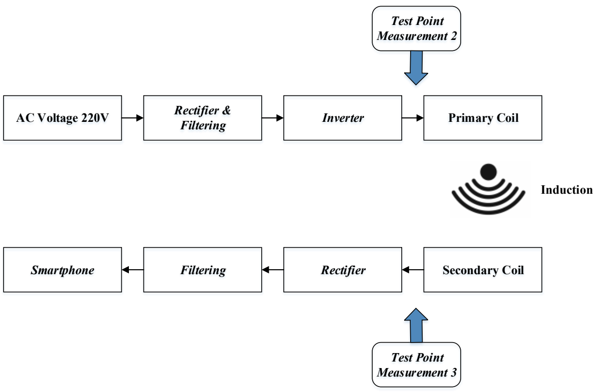

Figure 6. Block diagram of primary and coil secondary coil measurements

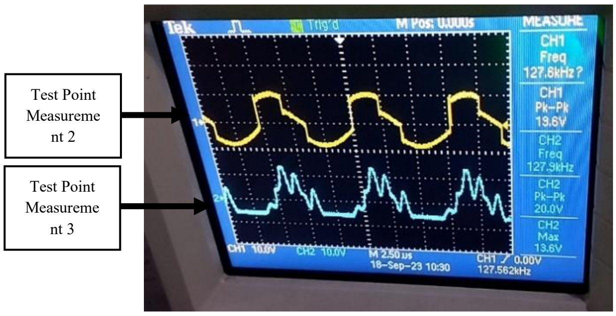

Figure 7. Oscilloscope results of primary and secondary coil measurements

Then on the primary coil side when there is no load in Figure 7 test point 2, a peak-to-peak voltage of 19.6V is produced with a frequency value of 127.6 kHz with a sine wave form, where these results are obtained after the process of changing the adapter which has a DC signal and then converted and amplified by the inverter circuit into an AC signal to produce a periodic electrical signal with a constant amplitude to be induced in the primary side winding. Meanwhile, on the secondary coil side, namely test point 3, a peak-to-peak voltage of 20V is produced with the same working frequency as the primary coil, namely 127.9 kHz with a triangular wave shape.

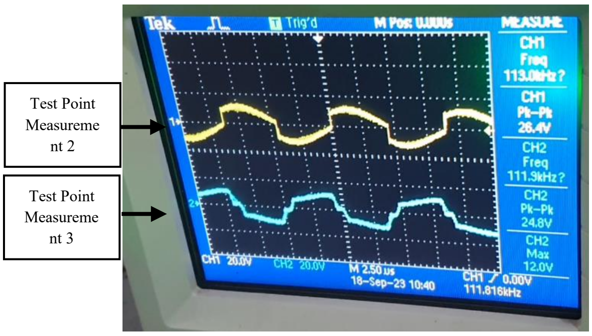

Figure 8. Oscilloscope results of primary and secondary coil measurements when there is a load

Likewise, if the load (cellphone) on the primary winding side in Figure 8 test point 2 produces a peak-to-peak voltage of 26.4V with a frequency value of 119 kHz with a sine wave shape, while on the secondary winding test point 3 a voltage of 24.8 is produced. volts with a working frequency of 111.9 kHz in the form of a square wave, where here there is an increase in peak-to-peak voltage but there is a decrease in the working frequency, of course this is because the primary side absorbs more power from the input from the adapter to be transferred to the output later but with a decrease in frequency which means the bandwidth is reduced so that the resulting power is more focused on being induced in the secondary coil so that it can then be optimally charged for charging the cellphone battery.

B. Results when there is & is not a load on the 15 watt Universal Wireless Charger device

The block diagram of measuring DC input at test point 1 and DC output on the secondary side at test point 4 shown in the Figure 9.

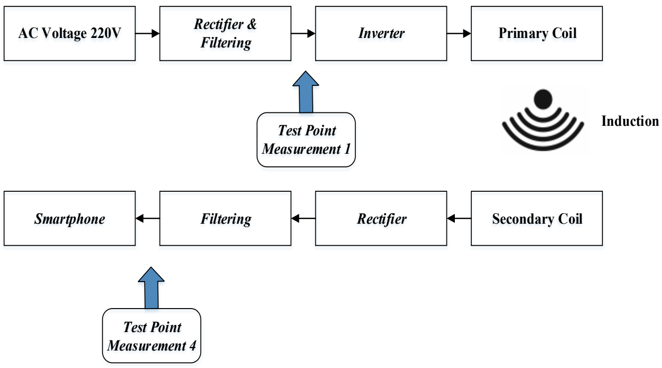

Figure 9. Block diagram of measuring primary side input and secondary side output

The results of the voltage entering the primary side when there is no load are shown in oscilloscope Fig. 10 test point 1, namely 1.00v with a working frequency of 25 MHz, here the voltage produced is not yet maximum because there is no load so the power distribution is not optimal which is of course almost the same as the side 10 watt primary which induces a peak-to-peak voltage of 1.60 volts, here the frequency wave produced is more towards positive polarity, while the dc output results when there is no load which is shown in oscilloscope Figure 10 test point 4, the resulting frequency is 20 MHz with The wave results are the same on the primary side input, namely flat and regular, the peak-to-peak voltage produced is more or less the same as the previous DC output measurement results, namely 800 mV.

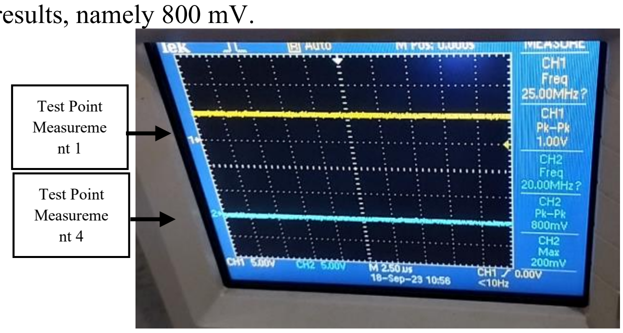

Figure 10. Results of oscilloscope measurements DC input & DC output

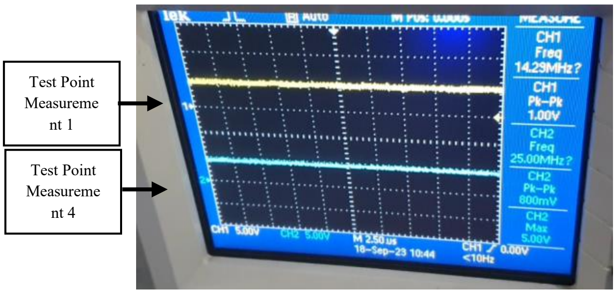

Figure 11. Results of oscilloscope measurements dc input & dc output when there is a load

Fig. 11 illustrates the oscilloscope output measurements when a cellphone is connected as a load to the system. Based on the observation at test point 1, the measured peak-to-peak voltage remains constant at 1 V, indicating that the presence of the cellphone load does not significantly affect the output voltage amplitude. This result is consistent with the no-load condition. However, a noticeable change occurs in the operating frequency, which decreases to 14.29 MHz compared to the unloaded condition. Despite this reduction in frequency, the waveform shape remains stable and closely resembles the waveform obtained when no load is applied, suggesting that the signal generation circuit maintains good stability under load conditions.

In addition, the DC output voltage measurement at test point 4, as shown in Fig. 12, demonstrates that the peak-to-peak voltage value also remains unchanged at 800 mV when the cellphone load is applied. This indicates that the DC regulation of the system is able to maintain voltage stability even when supplying power to an external device. Unlike the AC output at test point 1, the operating frequency at test point 4 increases when the cellphone is connected, reaching 25 MHz, compared to the frequency measured under no-load conditions. This increase in frequency may be caused by changes in the circuit impedance or switching behavior due to the additional load.

Furthermore, the waveform observed at test point 4 appears flatter and more regular, indicating improved signal stability under load conditions. Overall, the results show that the system maintains stable voltage characteristics during cellphone loading, while frequency variations depend on the measurement point. The similarity of waveform shapes between loaded and unloaded conditions confirms that the system operates reliably within acceptable performance limits.

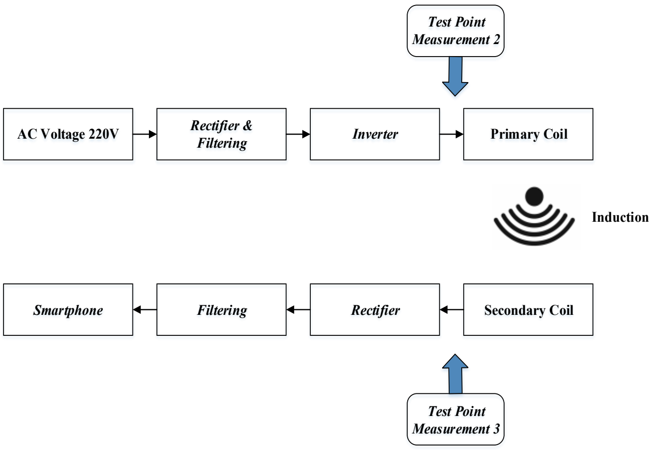

Figure 12. Block diagram of primary and coil secondary coil measurements

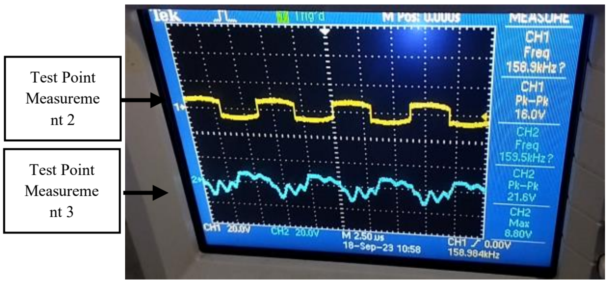

Figure 13. Oscilloscope results of primary and secondary coil measurements

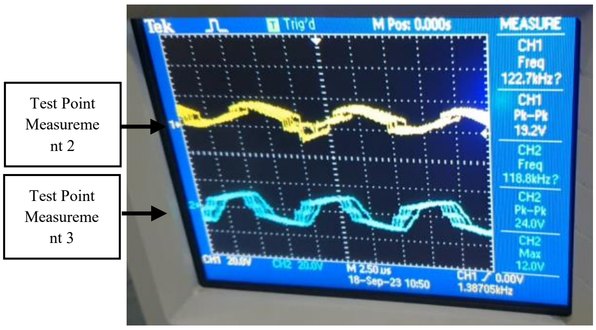

Figure 14. Oscilloscope results of primary and secondary coil measurements when there is a load

Furthermore, under no-load conditions as shown in Fig. 13, the primary coil at test point 2 produces a peak-to-peak voltage of 16 V with an operating frequency of 158.9 kHz and a square waveform. This waveform differs slightly from that of the 10 W primary side, which exhibits a sine waveform, and also operates at a lower frequency. Meanwhile, the secondary coil at test point 3 generates a peak-to-peak voltage of 21.6 V with a working frequency of 159.5 kHz, which is nearly identical to that of the primary coil and exhibits a triangular waveform.

When the cellphone load is applied, the primary coil (Fig. 14 test point 2) exhibits an increase in peak-to-peak voltage to 19.2 V with a reduced operating frequency of 122.7 kHz and a slightly distorted sine waveform. Similarly, the secondary coil (test point 3) produces 24 V at 118.8 kHz with a square waveform. This increase in voltage accompanied by a decrease in frequency indicates higher power absorption on the primary side, which enhances magnetic coupling efficiency and allows more effective power transfer to the secondary coil for optimal cellphone battery charging.

C. Differences in primary characteristics of 10 watt and 15 watt wireless chargers

From the test results when there is a load and no load, the overall results of the 10 watt primary side measurement are shown in the Table I.

TABLE I
COMPARISON TABLE OF MEASUREMENT RESULTS ON THE 10 WATT PRIMARY SIDE

	Dc Input (Tp1)	**Ac Coil (Tp2)**	**Ac Output (Tp3)**	**Dc Output (Tp4)**
Without load	Vpp = 1.60 v / 14.29 MHz	Vpp = 19.6 v / 127.6 kHz	Vpp = 20 v / 127.9 kHz	Vpp = 800 mv / 16.67 MHz
With Load	Vpp = 2.20 v / 25 MHz	Vpp = 26.4 v / 113 kHz	Vpp = 24.8 v / 111.9 kHz	Vpp = 800 mv / 33.33 MHz

The results in Table 1 show that when there is a load the peak-to-peak voltage results increase except at test point 4, namely the dc output which is relatively the same before there is a load. In the results of the dc input test point 1 & output test point 4 measurements, the results of the frequency when there was a load increased but it was different in the primary and secondary coils which experienced a decrease in frequency compared to when the cellphone was not loaded, here perhaps factors from the cross-sectional area or coil can influence the decrease frequency results. Meanwhile, to determine the induction value produced by the primary side winding, it needs to be calculated using an equation starting from finding the winding, as shown in Equation (1).

$$k = 2 \text{ x } \pi \text{ x } r \qquad (1)$$
$$k = 2 \text{ x } \frac{22}{7} \text{ x } 2{,}5$$
$$k = 15{,}71 \text{ cm}$$

After obtaining the circumference value, the next step is to calculate the total length of the winding. This calculation is performed by multiplying the circumference by the number of turns, as shown in Equation (2).

$$p = k \times n \qquad (2)$$
$$p = 15{,}71 \text{ x } 10$$
$$p = 157{,}1 \text{ cm}$$

Subsequently, the inductance value of the primary coil is calculated using the standard inductance formula, which incorporates the permeability of free space, the number of turns, the cross-sectional area, and the length of the winding, as shown in Equation (3).

$$L = \mu_0 \frac{n^2.a}{i} \quad (3)$$

$$L = 4\pi 10^{-7} \frac{10^2 x1.29x10^{-4}}{157{,}1x10^{-4}}$$

$$L = 1.031 \text{ x } 10^{-6} \text{ H}$$

$$L = 1.031 \ \mu\text{H}$$

So the inductance value released on the primary side winding is 1,031 μH. Even though the inductance value produced by a 10 watt primary winding is only 1,031 μH, the 10 watt primary coil has a fairly large coil area, namely 15.71 cm. Meanwhile, the overall results of the 15 watt primary side measurements are shown in Table 2.

TABLE II
COMPARISON TABLE OF MEASUREMENT RESULTS ON THE 15 WATT PRIMARY SIDE

	Dc Input (Tp1)	Ac Coil (Tp2)	Ac Output (Tp3)	Dc Output (Tp4)
With out Load	Vpp = 1 V / 25 Mhz	Vpp = 16 V / 158.9 Khz	Vpp = 21.6 V / 159.5 Khz	Vpp = 800 Mv / 20 Mhz
With Load	Vpp = 1 V / 14.29 Mhz	Vpp = 19.2 V / 122.7 Khz	Vpp = 24 V / 118.8 Khz	Vpp = 800 Mv / 25 Mhz

The results in Table 2 show that when there is a load, the peak-to-peak voltage results increase on the primary winding side, test point 2 and secondary test point 3, but on the results of the dc input test point 1 & output test point 4, whether there is or is not a load cellphones produce relatively the same peak-to-peak voltage.

In the measurement results of the primary and secondary coils which experienced a decrease in frequency compared to when the cellphone had not been loaded, except for the DC output which on the contrary experienced an increase, then To determine the inductance value produced by the primary-side winding, the calculation is carried out using the previously defined equations. First, the winding circumference is calculated using Equation (1) by substituting the coil radius value as follows:

$$k = 2 \text{ x } \frac{22}{7} \text{ x } 2{,}2 \text{ cm}$$

$$k = 13{,}82 \text{ cm}$$

Next, the total length of the winding is calculated based on Equation (2):

$$p = 13{,}82 \text{ x } 10$$

$$p = 138{,}2 \text{ cm}$$

Subsequently, the inductance value of the primary winding is determined using Equation (3) by substituting the calculated parameters:

$$L = 4\pi 10^{-7} \frac{10^2 x1.48x10^{-4}}{138{,}2x10^{-4}}$$

$$L = 1{,}345 \text{ x } 10^{-6} \text{ H}$$

$$L = 1.345 \ \mu\text{H}$$

So the resulting inductance value on the primary side winding is 1,345 μH. Even though the 15 watt primary side has a slightly smaller coil area compared to the 10 watt primary side, namely 13.82 cm, the 15 watt primary side has a slightly larger diameter and cross-sectional area compared to the 10 watt primary side so the induction value is higher. The output is slightly larger, namely 1,345 μH and the working frequency produced is also higher, between 118 kHz – 160 kHz when compared to the primary side of 10 watts.

D. Calculation of receiver winding induction

The secondary side used in this test is a universal secondary wireless charger device which in its specifications can produce a voltage of 5 volts with a current of 1 ampere which is not much different from the wireless charger from an iPhone or Samsung which is built-in on the cellphone. Here, because the winding shape in the secondary side circuit is square, the winding calculation to find the resulting induction value can be calculated, the inductance value is calculated using Equation (4):

$$k = \text{length of side 1} + \text{length of side 2} + \text{side length 3} + \text{side length 4} \quad (4)$$

$$k = 2{,}5 + 3{,}6 + 3{,}6 + 2{,}5$$

$$k = 12{,}2 \text{ cm}$$

After that, proceed with calculating the length of the winding with the following Equation (2):

$$p = 12{,}2 \text{ x } 10$$

$$p = 122 \text{ cm}$$

After that, continue by calculating the resulting inductance with the following Equation (3):

$$L = 4\pi 10^{-7} \frac{10^2 x 7 x 10^{-6}}{122 x 10^{-2}}$$

$$L = 7.210 \ x \ 10^{-10} \ H$$

$$L = 7.21 \ \mu H$$

So the inductance value released in the secondary winding is 7.21 μH. This secondary winding has a small inductance value because the cross-sectional diameter used is very small even though the windings used are parallel, so the effect is of course that the induction results from the primary side cannot be optimal and the resulting output will be limited.

These results indicate that the 10 W primary performs better than the 15 W primary when tested using the same secondary side. Although the inductance value produced by the 10 W primary coil is relatively smaller at 1.031 μH, it has a larger coil circumference of 15.71 cm, which contributes to a more stable operating frequency in the range of 111 kHz–128 kHz.

This frequency range results in a higher and more consistent peak-to-peak voltage, ranging from 19.6 V to 26.4 V. In contrast, the 15 W primary coil has a larger wire cross-sectional area of 1.48 mm, leading to a slightly higher inductance value of 1.345 µH and a wider operating frequency range of 118 kHz–160 kHz. However, the higher frequency variation causes the generated peak-to-peak voltage to be relatively lower and less stable, with values ranging from 16 V to 24 V. Consequently, the 10 W primary demonstrates better voltage stability and more effective power transfer characteristics when paired with the same secondary coil.

E. Effect of distance and charging time

In this research, wireless charging tests were conducted using a Xiaomi Redmi Note 11 smartphone equipped with a 5000 mAh battery that supports fast charging. The charging experiments were performed by varying the distance between the primary and secondary sides from direct contact up to 20 mm (2 cm) to evaluate the effect of distance on charging performance. The results of this distance variation are presented in Table III.

TABLE III
TABLE OF THE EFFECT OF DISTANCE ON WIRELESS CHARGING ON THE 10 WATT PRIMARY SIDE

Distance (mm)	Result Information
2	Connected and still able to charge
4	Connected and still able to charge
6	Connected and still able to charge
8	Connected and still able to charge
10	Connected and still able to charge
12	Connected and still able to charge
14	Not connected, unable to charge
16	Not connected, unable to charge
18	Not connected, unable to charge
20	Not connected, unable to charge

Based on Table III, the effect of distance on the wireless charging performance of the 10 W primary-side device is clearly observed. At the closest distance, namely when the primary and secondary devices are in direct contact, effective power transfer occurs, allowing the receiver to successfully charge the cellphone battery. This charging capability remains functional up to a maximum separation distance of 12 mm, where the receiver device is still able to receive power from the primary side. However, when the distance increases to 14 mm and beyond, up to 20 mm, the charging process can no longer be maintained. At these distances, the cellphone battery is not charged, and the primary-side device is unable to indicate a connection with the receiver, suggesting a significant reduction in magnetic coupling between the coils.

TABLE IV
TABLE OF THE EFFECT OF DISTANCE ON WIRELESS CHARGING ON THE 15 WATT PRIMARY SIDE

Distance (mm)	Result Information
2	Connected and still able to charge
4	Connected and still able to charge
6	Connected and still able to charge
8	Connected and still able to charge
10	Connected and still able to charge
12	Connected and still able to charge
14	Connected and still able to charge
16	Connected but unable to charge
18	Connected but unable to charge
20	Not connected, unable to charge

Similarly, Table IV presents the effect of distance on charging performance for the 15 W primary-side device. At the closest distance, ranging from direct contact up to 14 mm, the secondary-side device remains connected and is capable of charging the cellphone battery effectively. When the separation distance increases to 16–18 mm, the receiver device can still establish a connection with the primary side; however, the transferred power is insufficient to charge the cellphone battery. This condition indicates that although coil coupling is still present, the power transfer efficiency has decreased significantly. Furthermore, at a distance of 20 mm and beyond, the primary-side device can no longer detect or indicate the presence of the secondary-side device, and wireless charging of the cellphone battery cannot be performed.

TABLE V
THE CHARGING TIME FOR PRIMARY SIDE DEVICES IS 10 WATTS

No	Filling Percentage	Duration
1	0% - 10%	58,20 Min
2	10% - 20%	57,52 Min
3	20% - 30%	52,59 Min
4	30% - 40%	56,15 Min
5	40% - 50%	48,58 Min
6	50% - 60%	51,35 Min
7	60% - 70%	54,57 Min
8	70% - 80%	57,25 Min
9	80% - 90%	62,43 Min (1 Hour 2,43 Min)
10	90% - 100%	65,31 Menit (1 Hour 5,31 Min)

In addition, to evaluate the charging duration under optimal conditions, a long-duration charging test was conducted using a Xiaomi Redmi Note 11 cellphone at the closest distance, namely when the primary and secondary devices are in direct contact. This configuration was chosen to ensure maximum power transfer efficiency between the primary and secondary coils. The charging process was carried out from 0% to 100% battery capacity and divided into ten phases, with each phase representing a 10% increase in battery level. The charging results for the 10 W primary-side device are presented in Table 5, which provides a detailed observation of the charging performance over time.

Overall, these results demonstrate that the separation distance between the primary and secondary coils plays a critical role in determining wireless charging effectiveness. Higher primary-side power allows for a slightly greater effective charging distance; however, optimal charging performance is still achieved at minimal separation distances, particularly when the devices are in direct contact.

Table 1 The charging time for primary side devices is 10 watts.In Table 5, the average charging time for a 10 watt primary side device can be taken using the following Equation (5):

$$\text{Average (x)} = \frac{\text{total amount of time}}{\text{lots of data}} \quad (5)$$

$$x = \frac{58{,}20+57{,}52+52{,}59+56{,}15+48{,}58+51{,}35+54{,}57+57{,}25+62{,}43+65{,}31}{10}$$

$$x = \frac{563{,}95}{4}$$

$$x = 56{,}39$$

So the average time for charging the battery on a cellphone from 0% to 100% on a 10 watt primary side device is 56.39 minutes. Meanwhile, the length of increase of 1% can be calculated using the following Equation (6):

$$\text{Increase 1\% (p)} = \text{10\% x average charging time} \quad (6)$$

$$p = \frac{10}{100} \text{ x } 56{,}39$$

$$p = \frac{563{,}9}{100}$$

$$p = 5{,}693$$

So for an increase of 1% it takes around 5,693 minutes. Meanwhile, the 15 watt primary side device produces a charging time of 0% to 100% which is divided into 10 phases shown inTable 6.

In Table 6, the average charging time for a 15 watt primary side device can be taken using the following Equation (5):

$$x = \frac{61{,}46+64{,}50+62{,}43+60{,}03+67{,}42+68{,}19+70+73{,}37+76{,}58+81{,}05}{10}$$

$$x = \frac{685{,}03}{10}$$

$$x = 68{,}50 \text{ (1 Hour 8,50 Min)}$$

TABLE VI
THE CHARGING TIME FOR PRIMARY SIDE DEVICES IS 15 WATTS

No	Filling Percentage	Duration
1	0% - 10%	61,46 Min (1 Hour 1,46 Min)
2	10% - 20%	64,50 Menit (1 Hour 4,50 Min)
3	20% - 30%	62,43 Menit (1 Hour 2,43 Min)
4	30% - 40%	60,03 Menit (1 Hour 0,3 Min)
5	40% - 50%	67,42 Menit (1 Hour 7,42 Min)
6	50% - 60%	68,19 Menit (1 Hour 8,19 Min)
7	60% - 70%	70 Menit (1 Hour 10 Min)
8	70% - 80%	73,37 Menit (1 Hour 13,37 Min)
9	80% - 90%	76,58 Menit (1 Hour 16,58 Min)
10	90% - 100%	81,05 Menit (1 Hour 21,05 Min)

So the average battery charging time for a cellphone from 0% to 100% on a 15 watt primary side device is 1 hour 8.50 minutes. Meanwhile, the length of increase of 1% can be calculated using the following Equation (6):

$$p = \frac{10}{100} \text{ x } 68{,}50$$

$$p = \frac{685}{100}$$

$$p = 6{,}85$$

So for an increase of 1% it takes around 6.85 minutes. From the two data on the charging time on the 10 watt & 15 watt primary side devices.

IV. CONCLUSION

Based on the tests conducted, it can be concluded that the 15 W primary coil operates at a working frequency range of 118 kHz–160 kHz, while the 10 W primary coil operates at 111 kHz–128 kHz, with peak-to-peak voltage values for both coils ranging from 16 V to 27 V, which increase under load conditions. Although the DC input and output performance of both transmitters is not yet optimal, wireless charging of the cellphone battery can still be successfully performed. The 10 W primary device utilizes a toroidal coil with a radius of 2.5 cm, resulting in a winding circumference of 15.71 cm and a wire cross-sectional area of 1.29 mm, producing an inductance value of 1.031 μH, whereas the 15 W primary device employs a similar toroidal coil with a smaller radius of 2.2 cm, a winding circumference of 13.82 cm, and a larger wire cross-sectional area of 1.48 mm, resulting in a slightly higher inductance of 1.345 μH. In terms of charging distance, the 10 W primary system is able to induce charging up to a maximum distance of 12 mm and achieves faster charging performance, with an average charging time of 56.39 minutes per 10% from 0% to 100%, while the 15 W primary system can induce charging up to 14 mm; however, at distances of 16–18 mm, the secondary side can still be detected but is unable to charge the battery, and the average charging time increases to 68.50 minutes per 10%.

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