WIRELESS CHARGING FOR DRONES

TEAM MEMBERS :
Himanshu Gaurav (B21EE025)
Himesh Dhaka (B21EE026)

Change the way you connect!

ITS TIME TO GO FARTHER.

Limitation with current drone designs

- The power and flight time of drones are primarily their limitations.
- They can have bigger capacity lithium batteries added in them, but doing so makes them heavier and lowers the payload they can support.
- Drones must be recharged as a result.
- The autonomy of the devices is now limited by the need for human involvement during charging.

Why do we need wireless charger for drones ?

- LIMITATION OF BATTERY TECHNOLOGY
- LOW CHARGING TIME
- DEVICES CAN BE USED WHILE CHARGING
- ADJUSTABLE CHARGING ALIGNMENT, SECURE CONNECTIONS, AND TERRAIN RESISTANCE ARE ALL ADVANTAGES OF WIRELESS CHARGING.

What are the different methods in which we can achieve wireless charging?

1. **Inductive coupling**
2. **Capacitive coupling**
3. **Electrodynamic Wireless Power Transfer**
4. **Magnetodynamic coupling**
5. **Zenneck Wave Transmission**

What we are going to use?

Inductive coupling

Electromagnetic (EM) fields are used in inductive charging to transmit energy between two items. For this, charging stations were created. Electrical devices receive energy through inductive coupling. Battery charging is accomplished using this energy.

Using an induction coil and an inductive charger, the charging base produces an alternating electromagnetic field. The second induction coil is used by portable devices like vehicles and trucks to pick up the electromagnetic field. To revert these EM fields back into electric current and charge the drone's battery.

Resonant inductive coupling type can increase the distance between the transmitter and receiver coils.

RESONANT DAB CONVERTER

The resonant dual bridge converter is a type of power converter that is commonly used in wireless power transfer applications. It is designed to efficiently transfer energy wirelessly between a power source and a device without the need for physical contact. The converter consists of two active bridges, each with its own inductor-capacitor resonant circuit.

The resonant dual bridge converter operates by using two high-frequency switches, which control the flow of energy between the input and output sides of the converter. The two inductor-capacitor resonant circuits are connected with one circuit on the input side of the converter and the other on the output side. The two circuits are designed to operate at the same resonant frequency, which enables energy to be transferred efficiently between the input and output sides of the converter.

A BRIEF IDEALATION

A circuital model of a DAB converter has been developed using Simulink, a software tool within the Matlab programming environment.

This converter was constructed utilising coupled inductive coils as a wireless transfer medium.

The MOSFET has been employed as a switching mechanism due to its low voltage drop. The component functions as a resistor that can be controlled by voltage.

The values of the components in the converter have been calculated to achieve the desired output voltage for the drone.

Flow Chart

Decide the required output

Calculate the values of components

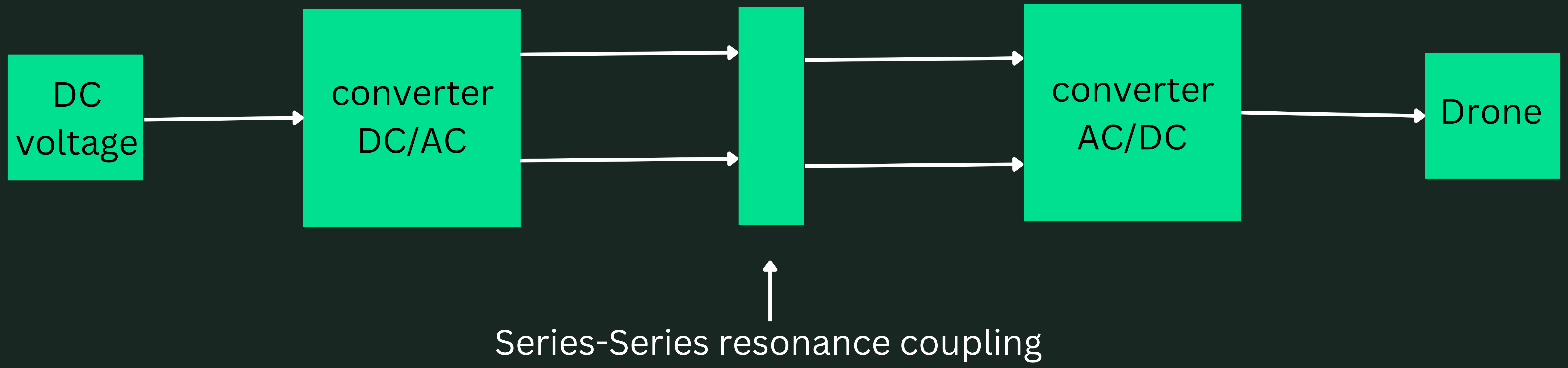
Make the appropriate circuit in Simulink

Set the calculated values in the components of circuit

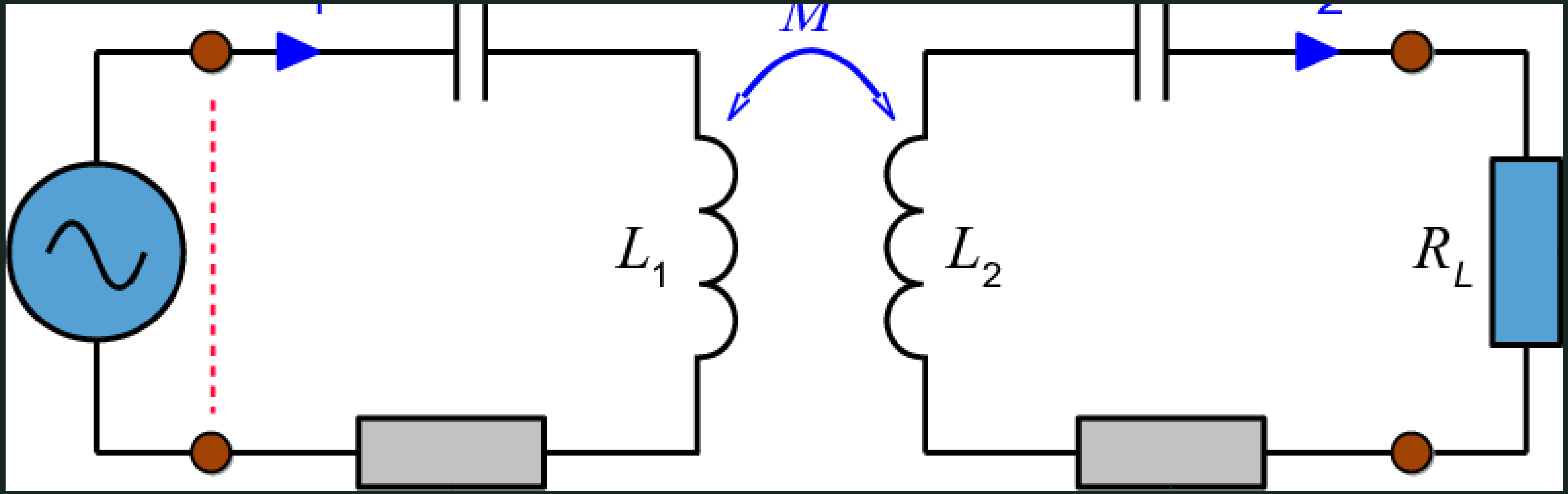
Observe the Output waveform

Compare it with Required voltage

Block Diagram



Series Series resonance coupling



pic reference :-https://www.researchgate.net/figure/Series-series-compensation-topology_fig1_341716295

Series-series resonance coupling is a type of resonant coupling that is commonly used in wireless power transfer systems. It involves connecting two resonant circuits in series, with one circuit serving as the transmitter and the other as the receiver. When the two circuits are tuned to the same frequency, energy can be transferred wirelessly between them.

In a series-series resonant coupling system, the transmitter and receiver circuits are typically composed of a capacitor and an inductor, arranged in series. The capacitor and inductor in each circuit form a resonant circuit that is tuned to a specific frequency.

What are the advantage of using series series coupling?

One of the key advantages of series-series resonance coupling is that it can achieve high levels of efficiency in power transfer. This is because the resonant circuits are designed to minimize energy losses and maximize energy transfer at the resonant frequency. Additionally, the use of resonant circuits allows for a wider range of coupling distances between the transmitter and receiver circuits, compared to other types of wireless power transfer systems.

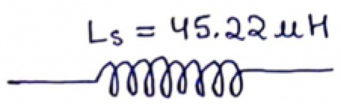
Requirements

Parameters	Value
Input DC voltage	48 volts
Required output voltage	20 volts
Required Output power	48 W
Resonant frequency	50 KHz
Quality factor	1.75
Coupling coefficient	0.7

Calculations

For the secondary side,

Secondary inductance is given by



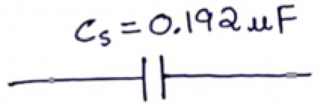
$$L_s = \frac{Q R_o}{\omega_r}$$

$$= \frac{1.75 \times 8.33}{2 \times \pi \times 50 \times 10^3}$$

$$= 4.522 \times 10^{-5}\ H$$

$$\boxed{L_s = 45.22\ \mu H}$$

Secondary Conductance,



$$C_s = \frac{1}{\omega_r^2 L_s}$$

$$= \frac{1}{(2 \times \pi \times 50 \times 10^3)^2 \times 4.522 \times 10^{-5}}$$

$$= 1.92 \times 10^{-7}\ F$$

$$\boxed{C_s = 0.192\ \mu F}$$

- Mutual inductance

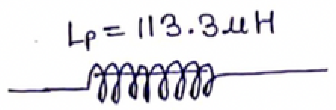
$$M = \frac{8 \cdot V_{dc} \cdot V_o}{\pi^2 \omega_r \cdot P_o}$$

$$= \frac{8 \times 48 \times 20}{\pi^2 \times (2 \times \pi \times 50 \times 10^3) \times 48}$$

$$= 5.04 \times 10^{-5}\ H$$

$$\boxed{M = 50.4\ \mu H}$$

For the primary side,



We know, $M = k\sqrt{L_s L_p}$

$$M^2 = k^2 L_s L_p$$

Primary inductance is given by

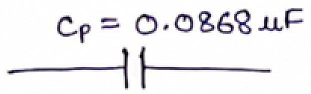
$$L_p = \frac{M^2}{k^2 L_s}$$

$$= \frac{(5.04 \times 10^{-5})^2}{(0.7)^2 \times 4.522 \times 10^{-5}}$$

$$= 1.133 \times 10^{-4}\ H$$

$$\boxed{L_p = 113.3\ \mu H}$$

Primary conductance,

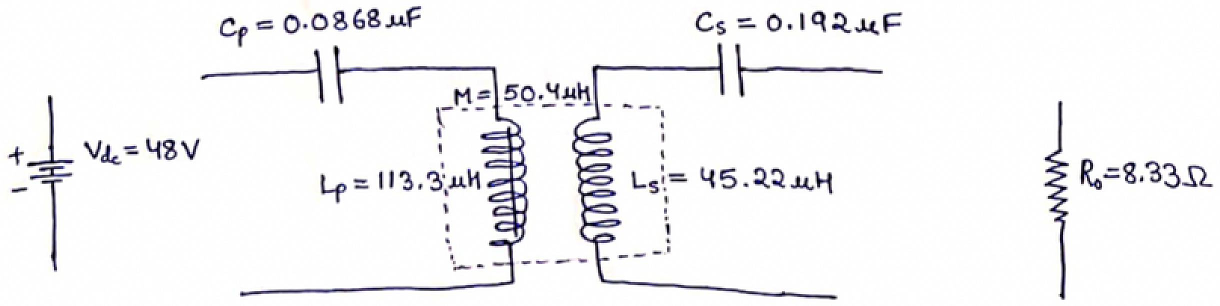


$$C_p = \frac{1}{\omega_r^2 L_p}$$

$$= \frac{1}{(2 \times \pi \times 50 \times 10^3)^2 \times 1.133 \times 10^{-4}}$$

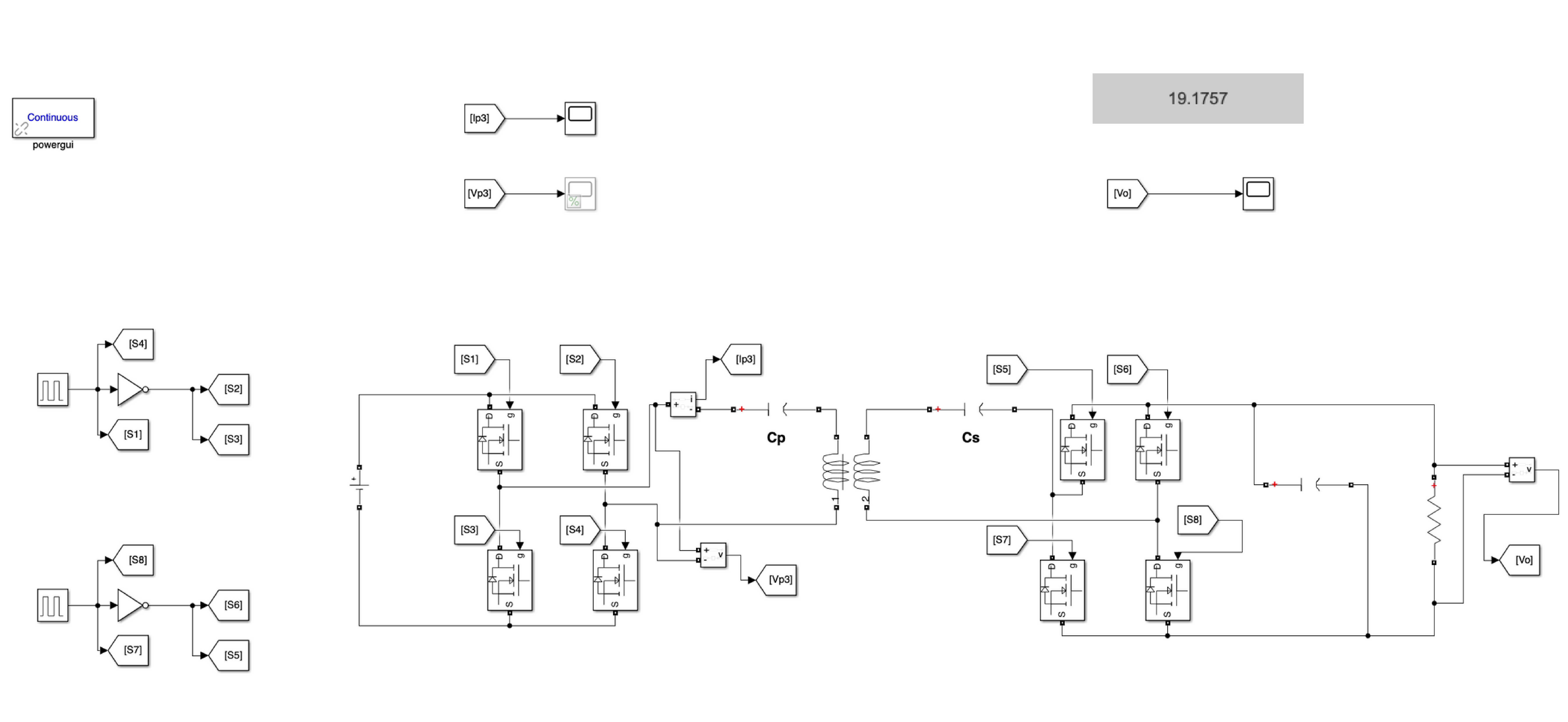
$$= 8.68 \times 10^{-8}\ F$$

$$\boxed{C_p = 0.0868\ \mu F}$$



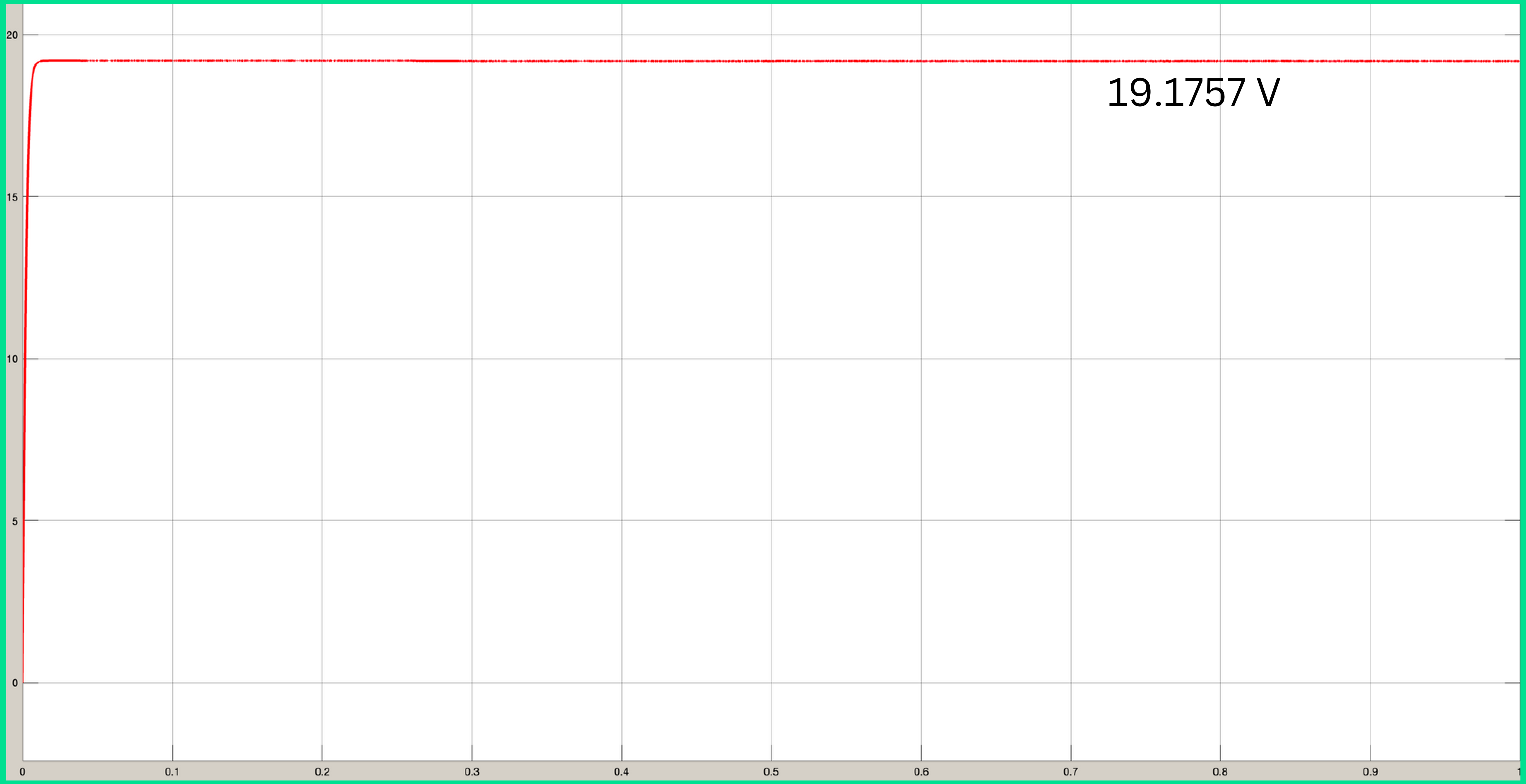
Circuit Diagram

The Circuit


Continuous
powergui
[Ip3]
[Vp3]
19.1757
[Vo]
[S4]
[S2]
[S1]
[S3]
[S8]
[S6]
[S7]
[S5]
[S1]
[S2]
[Ip3]
Cp
Cs
[S5]
[S6]
[S3]
[S4]
[Vp3]
[S8]
[S7]
[Vo]

OBSERVATION

Using the circuit made in Simulink, we have measured the voltage across the load resistor (having resistance as 8.33 Ω) which comes out to be 19.1757 V, close to the desired output value with an error of 4.12 %.The use of resonant components reduces the stress on the switching devices, leading to improved reliability and longer lifespan.



Output Voltage (V) vs Time (s)

CONCLUSION

We looked at how useful Resonant Dual Active Bridge Converter is for this project. We wanted to make a wireless charger and were able to do so with a 19.1757 V output voltage.

The converter was made to send power to the drone's battery quickly and wirelessly. It has shown that the output voltage (19.1757 V) is close to the desired output voltage (20 V). This shows that the converter works to send power to the drone, making it a more convenient and useful way for the drone to get the power it needs.

The converter can work from a variety of distances, which is useful for charging drones in the air or in places that are hard to reach. Also, because the converter is resonant, it is less affected by changes in distance. This makes the charging process more reliable.

FUTURE WORK

The range and efficiency of wireless charging systems can be affected by a variety of factors, including environmental conditions and the type of materials used in the construction of the charging system.

To address these challenges, further research and development is needed to improve the efficiency and reliability of wireless charging systems for drones. This may involve exploring new materials and designs for the charging system components, as well as developing more advanced control and monitoring systems to optimize the charging process.

REFERENCES

- 1) https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6165867
- 2) https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7309830
- 3) https://www.ti.com/lit/ug/tidueg2c/tidueg2c.pdf?ts=1682187635798&ref_url=https%253A%252F%252F www.google.com%252F
- 4)https://www.tutorialspoint.com/power_electronics/power_electronics_types_of_inverters.htm
- 5) https://www.youtube.com/watch?v=A78yP8oApqk (power electronics)
- 6) https://theses.lib.polyu.edu.hk/handle/200/9798

THANK YOU