DESIGN WIRELESS POWER CHARGING FOR BATTERY 12 VOLTS ON AUTOMATIC GUIDED VEHICLE

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ABSTRACT

In this era, technology is getting more advanced and develop rapidly. Most of every created technology requires an electrical energy. Along the current technology development, power or electrical energy delivery can deliver through air without using a cable as in general. However on AGV (Automatic Guided Vehicle) technology, charging power transfer is still conventionally using cable. The purpose of this paper is to resolve the power transfer process so that become more efficient.

By applying wireless charging technology, the charging process into AGV can be more efficient. A 220 V power source with 50 Hz frequency will be forwarded to the power supply which changes AC to DC then will be converted again to the inverter from DC to AC voltage forwarded directly to the primary coil through air delivery.

The results that have been achieved in this paper is the amount of power delivered more than 6.75 watts with a frequency of 9 KHz. The optimal distance for sending power is 0 - 5 cm. So the distance on wireless charging greatly affects the quality of the power delivery process performed.

Keywords: Wireless Power charging, Power Transfer, Inverter, Inductance

1. INTRODUCTION

In this era, technology and knowledge develop rapidly and full of innovation especially in electro-industry field. One example of technology development is the production process in industry is mostly carried out by machines or robots [4][5]. Robot in industry use cable as a medium for charging the power supply. However, it becomes inefficient in charging the power supply.

Wireless power transfer is one of the technologies that transmits electrical energy through the air. So that in charging process there is no need to use a cable as a transmission medium. This wireless charging will be implemented in Automatic Guided Vehicle (AGV), because it can be an alternative to transfer power without using a cable.

Implementation of wireless charging is called wireless charging. Wireless charging will be presented to AGV robots. In this project the level of efficiency in charging the AGV robot is influenced by the distance of the device with the coil and the length of charging that occurs. So the use of wireless charging in AGV robots can be more efficient than charging using cables.

2. WIRELESS CHARGING

Wireless charging is a technology that processes the transmission of electrical energy without going through a cable, but air as the transmission medium. This wireless charging technology is not much different from the system used in dynamo power plants or transformers. The laws of physics that used are when a coil of wire is supplied with electrical energy, it will cause a magnetic field. Otherwise, if a coil is subjected to a magnetic field, electricity will occur in the coil wire [6].

In a transformer, when the primary coil is connected to an alternating current voltage source, changes in the electric current in the primary coil cause a changing magnetic field. The changed magnetic field is strengthened by the presence of an iron core and is delivered to the secondary coil by an iron core, so that at the ends of the secondary coil induced GGL will arise [4]. In the transformer the amount of voltage released by the secondary coil is:

- Comparable to the number of secondary coil ($V_s \sim N_s$).
- Comparable to the magnitude of the primary voltage ($V_s \sim V_p$).
- Proportional inversely to the number of primary turns.

a. Inductance

Biot-Savart and Ampere law have shown that the presence of an electric current flowing in a conductor causes a magnetic field around the conductor. The magnitude of a magnet generated by an electric current is proportional to the magnitude of the electric current. Whereas the magnetic flux is $d\emptyset = B.dA$ and because B is proportional to I then the magnetic flux is also proportional to I [2].

b. Inverter

Inverter is a circuit that is used to change the DC voltage source to remain a source of AC voltage with a certain frequency. The semiconductor power components used can be SCR, transistors, and MOSFETs that operate as switches and modifiers. Inverters can be classified into two types: one phase inverter and three phase inverter. Each type of inverter can be grouped into four categories in terms of the commutation circuit types in the SCR, namely: (1) pulse width modulation, (2) resonance inverter, (3) auxiliary commutation inverter, and (4) complement commutation inverter [1].

Inverters are referred as voltage supply inverters (voltage-fed inverter-VFI) when the input voltage is always kept constant, called the current-supply inverter (CFI) when the input current is always kept constant, and is called a variable inverter (variable dc linked inverter) if the input voltage can be set. Furthermore, when viewed from the conversion process, the inverter can be divided into three types, namely inverter: series, parallel, and bridge. Bridge inverters can be divided into half-bridges and bridges [3].

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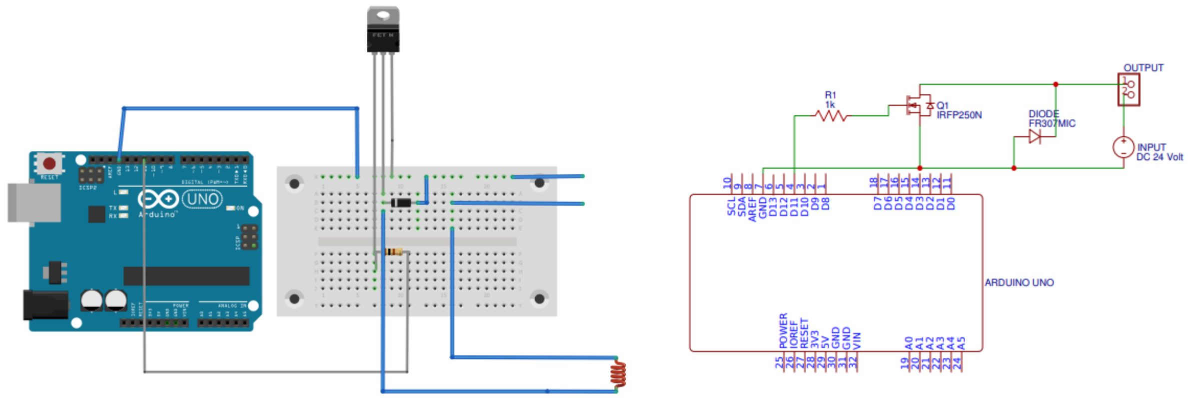

Figure 3 Inverter circuit

3.DESIGN SYSTEM

This time design will be designed a wireless charging system that is able to transmit power on a 12 volts AGV battery. The design will be divided into three parts, i.e. mechanical, electronic and software. The mechanical part is the manufacture of frames for the position of the primary coil and the placement of each component appropriately. The electronic part is part of determining the DC current that flows in each component and determines the frequency and AC voltage entering the primary and secondary coil. It also involves connecting each component correctly. The software section uses C language programming as the programming language of the Arduino Uno software to control the frequency generated by the inverter.

a. Block Diagram System

In general, the system that will be used in the final project will be illustrated in the block diagram below:

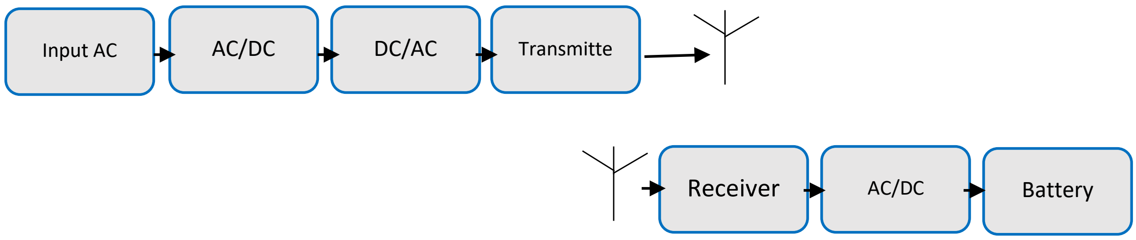

Figure 2: Block Diagram System

b. Designing the frame of primary and secondary coil

This design has a design made from insulating material, namely duplex paper so as not to affect the inductance of the coil. The shape of the coil frame dimensions is rectangular.

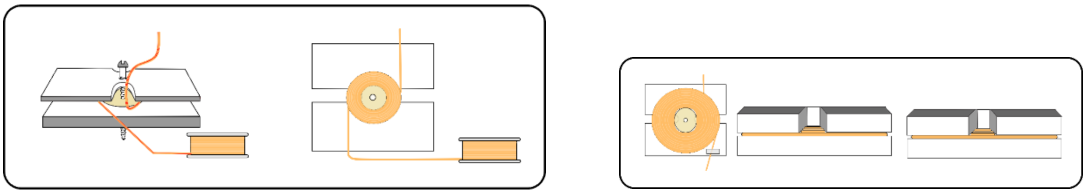

Figure 3: Process of Mounting Copper Wire on the Frame

c. Coil parameter

Table 4 : Coil Parameter

Par.	Nilai	Satuan	Keterangan
D	100	(mm)	Coil Diameter
L	6000	(mm)	Coil Length
N	62	(-)	Number of Turns
F	9	(kHz)	Frequency
L	6,3167	(μH)	Inductance
δ_l	0,06957	(mm)	Penetration depth

d. Inductance

$$\mathbf{L} = \frac{\mu.\pi.D^2 N^2}{4.l}$$

$$= \frac{\left(4\pi \times 10^{-7}\right).\ \pi\ .\ (0{,}1)^2(62)^2}{4\ .(6)}$$

$$= \mathbf{6{,}3167 \times 10^{-6}\ H = 6{,}3167\ \mu H}$$

e. Penetration Depth

$$\boldsymbol{\delta_l} = \sqrt{\frac{2\rho}{\omega\mu}} = \sqrt{\frac{2\ .(1{,}72 \times 10^{-8})}{2\pi\ .(9).(4\pi \times 10^{-7})}}$$

$$= \mathbf{0{,}0695765837\ mm}$$

4. TESTING AND ANALYSIS

Testing the inverter

The inverter circuit in this paper functions as a converter of DC voltage to AC voltage by increasing the frequency to 9 kHz, therefore testing the inverter circuit is done. Inverter testing is divided into two parts, a no-load inverter and an inverter with a load.

Inverter without coil

This test uses 24V DC input voltage and 24V AC output, following the inverter output image without load:

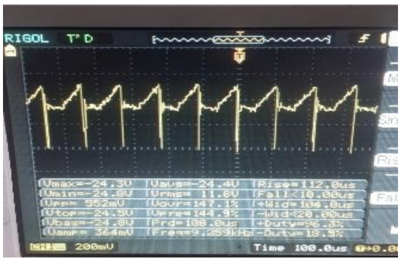

Figure 4: Inverter Signal without Coil on the Oscilloscope

Inverter with primary coil

This test uses a 26V DC input voltage and 24V AC output, following the inverter output image with the primary coil load:

Figure 5: Inverter Signal with Primary Coil on the Oscilloscope

Testing the coil

In testing the coil uses the input from the inverter output which is equal to 28.9 V. With 62 primary and secondary coils.

Testing the coil (Frequency of current and V output rectifier)

A primary coil input voltage of 28.9 V, coil distance between 0 cm, secondary coil output voltage of 11.7 V, 10 ohms resistor load. So the data is obtained as follows:

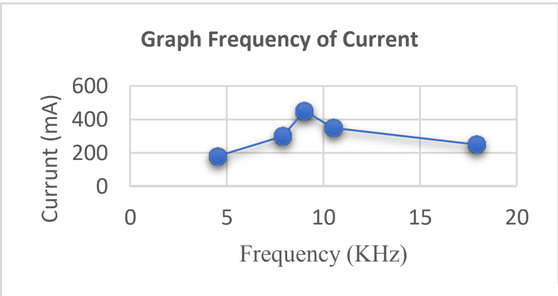

Figure 2 : Graph Frequency of Current

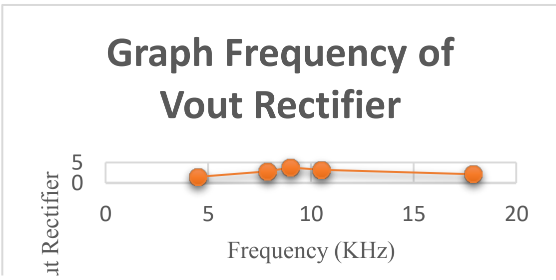

Figure 1 : Graph Frequency of Vout Rectifier

From the test results data we know that in the range of 4.5 kHz to 9 kHz the current has increased. In the range of 9 kHz to 17.9 kHz the current has decreased stably. So that from the above data at 9 kHz the maximum current is 450 mA.

Testing the overall system

Overall system testing is all system have been assembled into one. PLN AC voltage input 220 V - 50 Hz is converted to DC by the power supply to 24 V - 3A, then converted back to AC voltage with the aim of increasing the frequency of 9 KHz and transmitted by the primary - secondary coil. The secondary coil is connected to the rectifier to become a DC voltage again and is ready to charge the battery, following the data obtained:

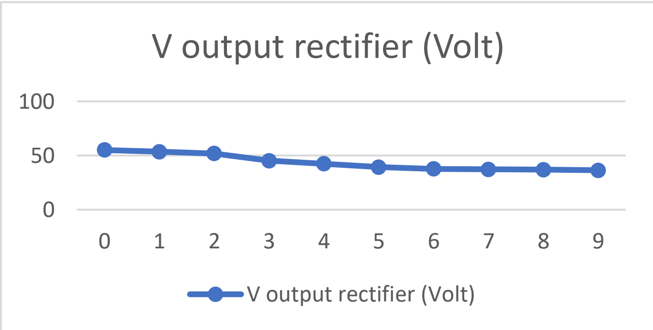

Figure 3 : Graph V Out System

From the data it can be seen the distance between the primary and secondary coil greatly affects the voltage which can be generated by the secondary coil, because the secondary coil gets the inductance force from the primary coil. It can be seen from the data above at a distance of 0 - 5 cm there is a stable voltage decrease at the rectifier output and at 5 - 9 cm a significant voltage drop occurs. The greater the distance between the primary coil and the secondary coil, the smaller the inductance force received by the secondary coil.

5. CONCLUSIONS

Based on the results of testing and analyzing the design of wireless charging systems, there are some conclusions as follows:

1. The distance between the primary coil and the secondary coil affects the output voltage. The farther the distance between the coil, the smaller the output voltage.
2. The wireless charging system works at a frequency of 9 KHz with power generated more than 6.75 watts.
3. Ideal distance to get the optimal output voltage from the charging wireless system that has been designed is 0 - 5 cm.
4. The magnetic field induction produced by the primary coil can send electrical energy to the secondary coil wirelessly.
5. Performing battery charging wirelessly longer than charging the battery using a cable.

6. Wireless charging system is more flexible in charging than charging the battery using a cable.

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