Electromagnetic Induction Amplifier System For Wireless Electric Power Transfer

Muhammad Try Satria
Bina Darma University
trysatria123@gmail.com

Nina Paramytha
Bina Darma University
nina_paramitha@binadarma.ac.id

Abstract

In recent years, technological advances have continued rapidly, including the shift from conventional electrical power transfer to wireless systems. The electric power transfer system in Indonesia generally still uses conducting cables, where this process has several weaknesses, one of which is related to operational costs. Apart from that, another weakness is related to the layout of the cables, which if left unorganized can cause short circuits and cause danger. So wireless power transfer is needed to minimize this problem. However, the application of wireless power transfer technology still has many obstacles. One of them is related to the unstable power produced, so a boosting system is needed so that the power produced can be stable. This research will focus on designing a prototype wireless electrical power transfer induction amplifier system. The results of this research show that the maximum distance measured between the transmitter and receiver coils is 27 cm with the addition of a repeater coil between the transmitter coil and receiver coil. The amplifier used is a diode bridge circuit on the transmitter in the form of a 5 A diode, 7812 transistor, 1000 µF & 2000 µF capacitors and for the receiver coil there are capacitors with a capacitance of 1000.728 µF each. The basic principle of voltage resonance from the transmitter so that it can be received by the receiver is to equalize the voltage resonance frequency between the receiver and transmitter.

Keywords: induction; wireless; power; prototype; electromagnetic

A. Introduction

The increasingly innovative development of industry 4.0 in Indonesia is accompanied by high competition in various sectors in society, including in the technology sector. This increasingly innovative technology encourages humans to create technology that is more efficient in its use(Rezeki et al., 2022). Technology without cables is often called wireless is a technological development needed in today's modern era. Dependency humans towards electronic devices is very noticeable in everyday life, where there are more and more. Electronic devices are getting more and more cables required for power transfer (Saputra et al., 2016). This is what causes the tool to be less efficient in its application. Several studies have discussed effective solutions to this problem. One of them is by creating a technique that provides a way to transfer energy wirelessly, not through cables but through the air. The technique used is to utilize the signal wave frequency transmitted by the coils (Adli et al., 2022; Wahyono & Hasanah, 2016). Meanwhile, the research carried out by (Kristiyono & Supriyanto, 2020) used the inductive coupling method for short distance transfers, induced resonance for medium distances and electromagnetic waves for long distances. Apart from that, research by (Firasanti et al., 2019) explains an energy transfer system using the copper coil method. Then research conducted by (Putri Endyani Pratiwi et al., 2022) used the influence of the number of coils using the Tesla coil method. Some research does not only focus on the types of coils but also focuses on determining the variable load, such as in the research conducted by (Putu Nanda Nugraha Utama et al., 2021) using lamp loads. Then (Dwi Prakoso et al., 2020) research used a charger as a load. Previous research, such as research conducted by (Luthfi & Rivai, 2020), resulted in a maximum distance of 20 cm between the transmitter, wire coil and receiver in supplying electrical power without cables. And research carried out by (Uranus, 2017) has produced a design for a device that is capable of supplying electrical power without cables up to a maximum distance of 9 cm. From these two studies, it was concluded that the electrical power transfer distance from the transmitter to the receiver was still too close. Therefore, this research focuses on the maximum distance in wireless electrical power transfer.

B. Method

The stages in this research begin with tool planning, hardware planning, tool design. Tool planning is related to the planning process in making a tool which is an important part in tool design. Proper and accurate planning will produce tools that meet the expected specifications. Then proceed with making a block diagram according to the overall tool design. The next step is the design creation stage. The aim is to determine the component layout so that the components can be installed as they should. And the flowchart functions as a framework for tool design.

C. Results and Discussion

In this research, the prototype is composed of several components such as a 12V transformer, diode, capacitor, IC regulator 7805, ESP32 microcontroller, INA219 sensor and ultrasonic sensor. Several components are assembled in such a way and will produce the prototype presented in the Figure 1 below.

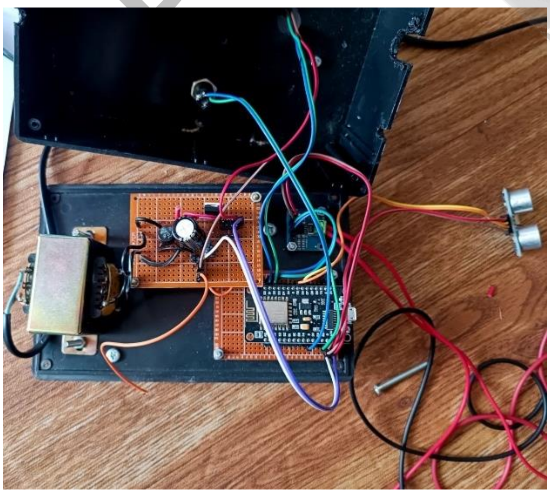

Figure 1. The Power Supply

This research carried out tests in the form of measurements at measurement points on the device's power supply. The measurement results can be seen in table 1 below.

Table 1. The Measurement Results

Measurement Position	Measurement Point	Unit	Number of Measurements					X	Description
Power Supply	TP 1 Input trafo	Vac	216	217	217	223	223	219	Input Trafo
	TP 2 Output trafo	Vac	9.18	9.18	9.22	9.21	9.21	9.20	Input Dioda
	TP 3 Output dioda	Vdc	10.19	10.02	10.13	10.18	10.18	10.14	Output Dioda
	TP 4 Output Kapasitor	Vdc	4.43	4.43	4.43	4.43	4.43	4.43	Output Kapasitor
		Idc	0.70	0.70	0.70	0.70	0.70	0.70	Output Kapasitor
	TP 5 Output regulator 7812	Vdc	12.11	12.09	12.09	12.11	12.11	12.10	Output Kumparan Transmitter
	TP 6 Output regulator 7805	Vdc	5.03	5.03	5.03	5.03	5.03	5.03	Output Mikrokontroler
	TP 7 Input LCD	Vdc	5.03	5.03	5.03	5.03	5.03	5.03	Output Mikrokontroler
	TP 8 Input Sensor Jarak	Vdc	5.03	5.03	5.03	5.03	5.03	5.03	Output Mikrokontroler
	TP 9 Echo Ultrasonik	Vdc	3.04	4.46	3.04	3.04	3.05	3.33	Output Transmitter
Kumparan Transmitter	TP 10 Output Transmitter	Vdc	12.11	12.11	12.11	12.12	12.10	12.11	Kumparan Receiver
Kumparan Receiver	TP 11 Output Receiver	Vdc	2.40	2.30	2,5	2.40	2.30	1.88	Beban
		Idc	0.30	0.30	0.20	0.10	0.30	0.24	Beban

From the results of the measurements that have been carried out, the percentage error can be determined which is shown in table 2 below.

Table 2. The Error Percentage

No	Measurement Points	Measurement Positions	Datasheet (Volt)	Measurement Result (Volt)	Calculation Result (Volt)	Error %	Description
1	Power Supply	TP1	220	219	-	0,4%	Standby
2		TP2	-	9.20	9.81	-0,6 %	Standby
3		TP 3	-	10.14	10,061	0,78 %	Standby
4		TP 4	-	4.43	-	In range	Standby
5		TP 5	12	12.10	-	0,2 %	Standby
6		TP 6	5	5.03	-	0,5%	Standby

The test is carried out when there is a receiver in front of the transmitter. The ultrasonic sensor will inform you of the presence of a receiver in front of it. In Figure 2, the ultrasonic sensor is in the ON position when the receiver detected in front of it will immediately provide input to the ESP32 to activate the transmitter to send an induced wave to the receiver circuit.

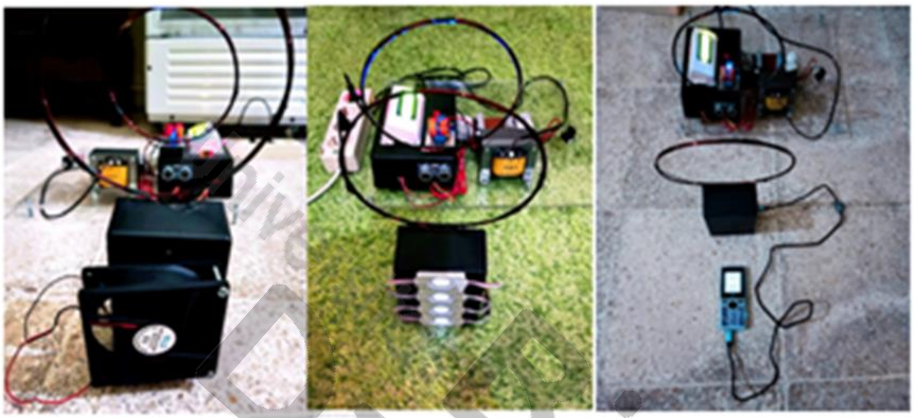

Figure 2. The Testing of Receiver Without Using a Repeater

Based on the measurement points of the receiver circuit without repeaters, the measurement results are obtained in table 3 below.

Table 3. The Receiver Measurement Results Without Using a Repeater

	Transmitter				Load Receiver						
No	V (V)	P (W)	I (A)	L (µH)	Distance	Fan V	Fan I (mA)	LED Lamp V	LED Lamp I (mA)	Charger V	Charger I (mA)
1					11	9	58	2.2	17	5.8	163
2					12	8	44	1,2	13	5.40	152
3					13	5	42	0,9	10	5.23	146
4					14	3.5	38	0,6	10	4.90	133
5	24	12	0.5	10	15	2.7	33	0,23	9	4.83	127
6					16	2.2	27	0,19	8	4.63	118
7					17	2	20	-	-	4.46	108
8					18	1.7	18	-	-	4.21	90
9					19	1	10	-	-	4.05	62
10					20	0.7	6	-	-	3.95	52

Measurement of the receiver coil uses repeater circuit coils (receiver coil circuit on the charger) placed parallel and in the middle between the transmitter circuit coils and the load circuit coils. The repeater circuit winding is placed at a distance of 17 cm after the transmitter and then adding the load circuit winding. For measurement points on the transmitter and receiver using a repeater starting from a distance of 17 cm, the measurement results are obtained in the table 4 while an illustration of this series can be seen in Figure 3.

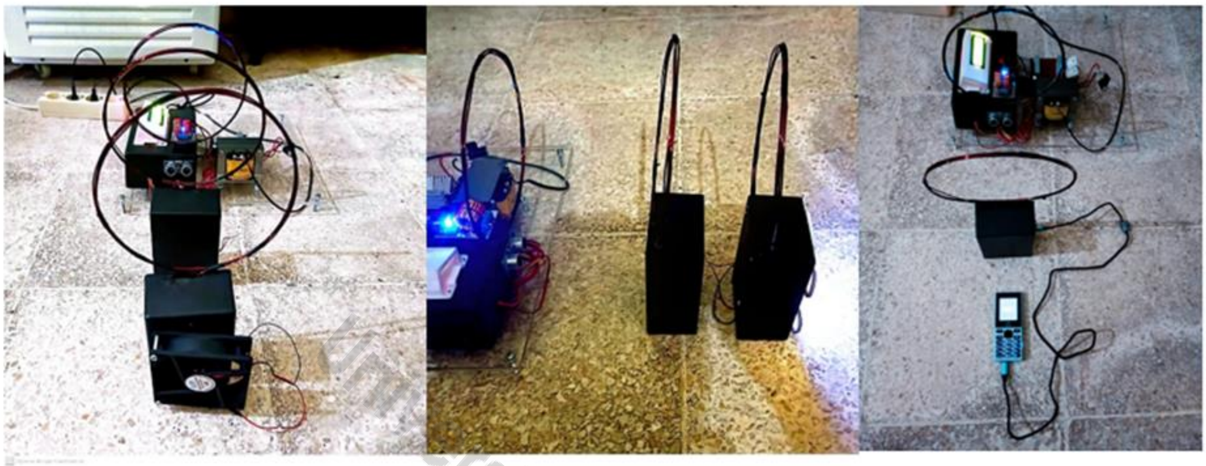

Figure 3. The Testing of Receiver Using a Repeater

Table 4. The Receiver Measurement Result Using a Repeater

No	Transmitter				The Distance of Transmitter and Repeater	Load						
	V (V)	P (W)	I (A)	L (Mhz)		Receiver						
						Jarak	Fan		LED Lamp		Charger	
							V	I (mA)	V	I (mA)	V	I (mA)
1						18	8.7	58	2,9	35	4.21	90
2						19	7	44	2,3	31	4.05	62
3						20	5	42	2,0	27	3.95	52
4						21	3.5	38	1,8	25	2.25	36
5	24	12	0.5	10	17 cm	22	2.7	33	1,4	24	-	-
6						23	2.2	27	1,0	20	-	-
7						24	2	20	0,4	18	-	-
8						25	1.7	18	0,35	15	-	-
9						26	1	10	0,3	13	-	-
10						27	0.7	6	0,18	5	-	-

D. Conclusion

The research results show that the transmitter circuit uses a 5 ampere diode bridge amplifier, an electrolytic capacitor of 3200 µF and uses induction from a ZVS mini transducer which has 10 µH induction. And the receiver circuit uses mylar, film and electrolytic capacitors with a capacitance value of 1000.728 µF. Meanwhile, the use of a repeater coil in the charger circuit can be used to design an electromagnetic induction circuit to further transmit energy to the receiver. Based on the measurement results of the receiver without a repeater, it was found that the maximum distance for induction transfer from the transmitter winding to the receiver winding was 20 cm for the fan load, 13 cm for the LED light load and the maximum distance was 20 cm for the charger load. Furthermore, the receiver measurement results using the repeater were 27 cm for the fan load, 23 cm for the light load, and 20 cm for the charger load.

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Journal of Social Work and Science Education

E-ISSN 2723-6919 P-ISSN 2746-0827

URL: https://ejournal.karinosseff.org/index.php/jswse/, Email: jswse@karinosseff.org

Date: 21 August 2023

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Congratulations!

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Palembang, Agustus 2023
Ketua Program Studi Teknik Elektro
Universitas Bina Darma

Dosen Pembimbing

Ir. Nina Paramytha IS, M.Sc
NIP.120109354

Ir. Nina Paramytha IS, M.Sc
NIP.120109354