Optimization and Performance Analysis of Conventional Boost Converter Topology by Varying Inductor Diameter

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Abstract - *Inductors have a significant influence on the volume, weight, cost, and performance efficiency of converters. In boost converters, the size of the inductor greatly affects the overall size of the converter. In recent years, there has been an increasing number of researches focusing on modeling power losses in magnetic elements and on the influence of power losses in these elements on the characteristics of electronic equipment. Boost converters often operate under non-ideal conditions, when the switch is active for a long period of time (Switch ON), conduction losses increase, high current ripple occurs, and the switch operating cycle is extreme. The magnitude of current ripple in a boost converter will greatly affect the amount of power loss generated in the inductor or MOSFET. Given this, it is important to consider the inductor's ability to overcome power losses that will affect the performance of the boost converter. This research analyzes the effect of inductor size, voltage, current, and efficiency related to the duty cycle. The purpose of this research is to find the highest efficiency by varying the diameter of the inductor wire. The diameter of the inductor wire will affect internal resistance and power dissipation, which will have an impact on the performance of the boost converter. Based on the research results obtained, a diameter of 1.5* mm *achieved the most optimal performance with an efficiency of 69.05%. Increasing the diameter of the inductor will improve its ability to store current* (IL) *and reduce internal resistance, thereby overcoming the magnitude of current ripple* (ΔI_L)*, reducing power losses due to heat, and converting energy efficiently.*

Keywords: *Boost Converter; Inductor Diameter Variations; Efficiency*

INTRODUCTION

Currently, PV systems are widely used in residential, industrial, and electric vehicle charging applications. PV systems have disadvantages during operation, namely voltage fluctuations and low DC output voltage (Anshory et al., 2024). To meet the needs of a promising and growing industry, a boost converter is needed to increase the low output voltage and eliminate voltage fluctuations in the solar panel output (Hardian et al., 2025; Raj & Praveen, 2022).

A boost converter is a device with high efficiency, as it can increase the output voltage without having to eliminate excess power from the solar panel (Shaw, 2019). Theoretically, the input power supplied will be equal to the output power generated. However, DC-DC converter elements often operate under non-ideal conditions and have certain parasites or non-idealities (Vishwanatha & Yogesh V. Hote, 2017).

Boost converters with conventional topologies are widely used in step-up applications, mainly due to their simple and efficient structure (Koç et al., 2022; Shaw, 2019).

When the switch is active for a long period of time (Switch ON), conduction losses will increase, high current ripples will occur, and the switch's operating cycle will be extreme. Parasitic components such as inductance values will limit the voltage gain that has been achieved (Koç et al., 2022; Lopez-Santos, 2020).

(Hardian et al., 2025) research by designing a conventional boost converter using Arduino Uno control. The inductor variations were carefully selected, using 30 turns and 60 turns of wire with a diameter of 1 mm. The inductor with 60 turns of wire with a diameter of 1 mm achieved the highest efficiency compared to the other variations. From the data studied, it was concluded that the more turns there are, the higher the inductance value will be, but the resistance value will also be higher.

The performance of boost converters is greatly influenced by various parameters, one of which is the inductor component. Inductors are key components in the working principle of most industrial power electronic converters. Inductors have a significant effect on the volume, weight, cost, and performance efficiency of converters (Barrios et al., 2021). As a result, inductor design and validation are critical steps in the converter design and operation process (Barrios et al., 2021; Mahardhika Harilinawan, 2024). In boost converters, the size of the inductor greatly affects the overall size of the converter (Pauzi et al., 2020; Srija et al., 2019).

Inductors have an important role in the process of energy storage and transfer, and determine the characteristics of converter operating modes, namely Continuous Conduction Mode (CCM) and Discontinuous Conduction Mode (DCM). These operating modes affect efficiency, current and voltage ripple, and overall system stability (Barrios et al., 2021; Gozim et al., 2015). Power loss factors and CCM conditions greatly influence the efficiency values produced by boost converters.

The greater the power losses in a boost converter, the lower its efficiency will be (Laksono et al., 2018; Mohamed & Ayad Bastawrous, 2020). The magnitude of current ripple in a boost converter will greatly affect the power losses generated in the inductor or MOSFET (Hardian et al., 2025). In recent years, there has been an increasing number of studies focusing on modeling power losses in magnetic elements and the effect of power losses in these elements on the characteristics of electronic equipment (Koç et al., 2022).

Considering that boost converters always operate under non-ideal conditions, it is important to consider the inductor's ability to overcome power losses that will affect the performance of the boost converter.

The purpose of this research is to find the highest efficiency by varying the diameter of the inductor wire. The diameter of the inductor wire will affect the internal resistance and power dissipation, which will have an impact on the performance of the boost converter.

RESEARCH METHODS

This research uses a method similar to that used in (Hardian et al., 2025) namely a quantitative method, which will analyze the effect of inductor size, voltage, current, and efficiency related to the duty cycle.

The boost converter circuit that has been designed (Hardian et al., 2025) will be developed in this research by varying the wire diameter on the inductor by 0.5 mm, 1 mm, and 1.5 mm with 60 turns.

The variation in the diameter of the inductor wire correlates with a decrease in the inductor's internal resistance and its ability to store current, which will have an impact on increasing system efficiency.

This research focuses on analyzing the efficiency (η) of conventional topology boost converter performance with varied inductor diameters to obtain optimal performance.

$$\eta = \frac{P_{out}}{P_{in}} \times 100\% \quad (1)$$

Conventional Boost Converter

The design of a conventional boost converter circuit has been previously designed in research (Hardian et al., 2025). Figure 1 below shows the boost converter-based power conversion system used in this research. The system consists of several main components, namely a solar panel as the main energy source, a boost converter circuit, a gate driver, an oscilloscope, and an Arduino Uno.

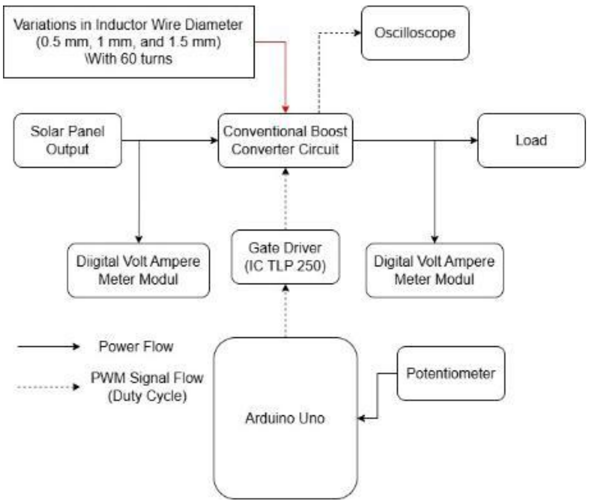

Figure 1. Block Diagram of the Boost Converter Power Conversion System

A boost converter consists of various power electronic components such as MOSFETs, capacitors, Schottky diodes, resistors, and inductors (Hardian et al., 2025). The working principle and circuit design of the boost converter used have been described in detail in previous research (Hardian et al., 2025). The conventional boost converter circuit designed consists of a control circuit, a gate driver circuit, and a boost circuit.

The control circuit used is an Arduino Uno to control the output voltage of the boost converter by adjusting the duty cycle value using a potentiometer. Control is performed by supplying a PWM signal that controls the ON and OFF periods of the switch/MOSFET (Anshory et al., 2024; Hardian et al., 2025).

To control the MOSFET switch operation so that it is more stable and isolated from high voltage interference, an optocoupler IC-based gate driver circuit is used. This IC functions to amplify the PWM signal generated by the Arduino Uno microcontroller and to activate and switch the MOSFET gate on the boost converter while also acting as an isolator between the Arduino Uno-based control circuit and the power circuit of the boost converter (Hardian et al., 2025; Lopez-Santos, 2020).

This research focuses on optimizing the efficiency of a boost converter by varying the diameter of the inductor that utilizes solar panel resources. The entire system is designed to determine the inductor's ability to store current and overcome current ripple, which will affect the increase in efficiency in the boost converter. Table 1 shows the boost converter parameters used in this research.

Table 1. Boost Converter Parameters

Parameter	**Symbol**	**Value**
Input Voltage	Vin	19.5 V – 20.3 V
Inductance diameter 0.5 mm (60 turns)	L	16.3 mH
Inductance diameter 1 mm (60 turns)	L	16.3 mH
Inductance diameter 1.5 mm (60 turns)	L	16.3 mH
Dioda Schottky	I_{max}	3 A
Resistance	R	102 Ω
Capacitance	C	100 μF
Switching Frequency	f	25 KHz
Duty Cycle	%	10 – 60 %
Output Voltage	$Vout$	19.9 V – 46.6 V

Gate Driver Circuit

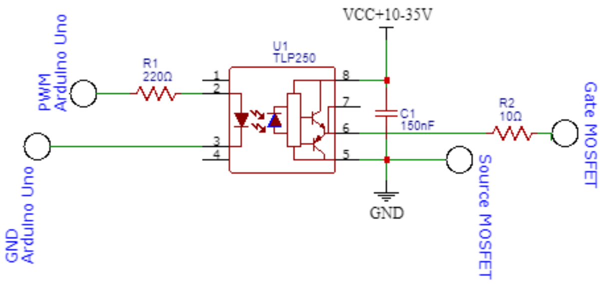

Figure 2. Gate Driver Circuit

The IC Octocoupler used is the TLP 250 IC. In Figure 5, the TLP250 receives Vcc supply from the solar panel circuit. Between PIN 8 and the output ground (PIN 5) on the TLP250 circuit, there is also a 150 nF bypass capacitor. The specifications of the IC used are listed in Table 2 below.

Table 2. Specifications of IC TLP 250

Parameter	Symbol	Value
Input threshold current	mA	5 mA (max)
Supply current	Icc	11 mA (max)
Supply voltage	Vcc	$10 - 35\ V$
Output voltage	Vo	$24 - 35\ V$
Output current	Io	$\pm 1.5\ A$
Operating temperature range	$Topr$	$-20\ to\ 85$ °C
Isolation voltage	rms	$2500 Vrms$ (min)

MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor)

The MOSFET used in this research is the IRF540N MOSFET. It is used in a boost converter circuit because it has a fast response when switching between ON and OFF conditions. The switching process in MOSFETs greatly affects the magnetization and demagnetization processes in inductors (Hardian et al., 2025). The specifications of the MOSFET used in this research are shown in Table 3 below.

Table 3. Specifications of MOSFET IRF540 N

Parameter	Symbol	Value
Drain to Source Voltage	V_{DS}	$100\ V$
Drain to Gate Voltage	V_{DG}	$100\ V$
Gate to Source Voltage	V_{GS}	$\pm 20\ V$
Drain Current	I_D	$33\ A$
Operating and storage temperature	T	$-55\ to\ 175$ °C

Inductor

The inductor used in this research is made of enameled copper wire. The copper wire is wound around a ferrite core, which acts as a storage for the converted current to increase the output voltage in the boost converter.

- Inductance and Resistance

The inductance and series resistance values of an inductor can be calculated using formulas (2) and (3) below (Assyidiq et al., n.d.; Hardian et al., 2025; Marahatta et al., 2022).

$$L = \frac{N^2 x\ \mu_0\ x\ \mu_r\ x\ A}{\ell_{ef}} \quad (2)$$

$$R = \frac{\rho \ell}{A} \quad (3)$$

- Inductor Current

Current will be stored in the inductor when the MOSFET is in the ON state. (IL), (IL_{min}) and (IL_{max}) stored in the inductor depend on the inductance and series resistance of the inductor. The average current (IL), minimum current (IL_{min}), and maximum current (IL_{max}) in the inductor can be calculated using equations (4), (5), and (6) below (Hardian et al., 2025; Hauke, 2009; Mahmood & Selman, 2016).

- IL

$$IL = \frac{Iout}{(1-D)} \quad (4)$$

- IL_{min}

$$IL_{min} = IL - \frac{\Delta i_L}{2} \quad (5)$$

- IL_{max}

$$IL_{max} = IL - \frac{\Delta i_L}{2} \quad (6)$$

- Current Ripple $(\Delta I_{L(ON)})$

$(\Delta I_{L(ON)})$ is the current ripple generated when the MOSFET is in the ON state, where the inductor is directly connected to the input voltage source and the accumulation of current or magnetization process occurs in the inductor (Hardian et al., 2025). Equation (7) is the formula for calculating current ripple when the MOSFET is ON (Assyidiq et al., n.d.; Hauke, 2009).

$$\Delta i_{L(ON)} = \frac{DVin}{LF} \quad (7)$$

RESULTS AND DISCUSSION

Results

Solar Panel Tested

Solar panel tested is based on the electrical characteristics produced by each PV used. This research is a $LUX - P$ curve test that describes the relationship between light intensity and the power produced by the two PV modules used.

The research (Hardian et al., 2025) tested both solar panels, while the research conducted in this research used three solar panels. The difference in the number of panels used was due to the difference in the number of parameters for the inductor size variation being studied. The testing was conducted to ensure that the series in this research could run according to the desired objectives.

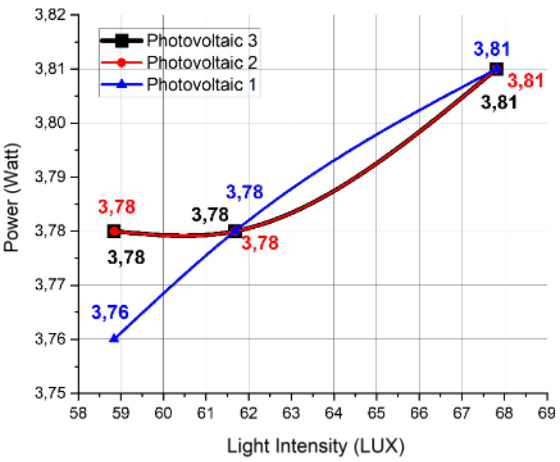

Figure 3. Characteristic Graph LUX – P PV Module

From the $LUX - P$ test results graph, the power characteristics produced are not significantly different between the three PV modules used. It can be concluded that all three solar panels can be used as the main power source in this research.

The electrical characteristics produced will vary with changes in environmental conditions. This test is important to determine the differences in the efficiency of the three PV modules in generating electricity from sunlight (Hardian et al., 2025). This research used three 100 Wp PV modules with the same specifications as shown in Table 4 below.

Table 4. Parameters of 100 Wp Solar Panel

Parameter	Symbol	Value
Peak Power	$Pmax$	100W
Cell Efficiency	%	16.93%
Maximum power voltage	Vmp	17.8 V
Maximum power current	Imp	5.62 A
Open circuit voltage	Voc	21.8 V
Short circuit current	Isc	6.05 A
PV Operating Temperature	^0C	$-4^{0C}\ to{+}8^{0C}$
Maximum system voltage	VDC	1000 $V\ DC$

Tested Boost Converter Circuit

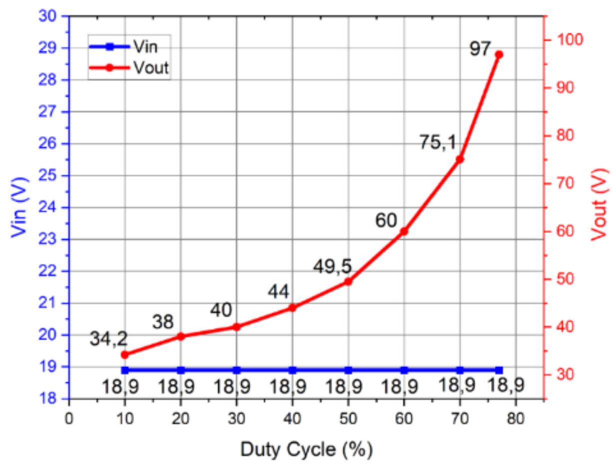

Figure 4. Boost Converter Test Graph

The data graph in Figure 4 shows the results of testing the boost converter using an inductive load. From the data obtained, it can be concluded that the boost converter that has been made can work according to theory.

The boost converter works to increase the output voltage. The greater the duty cycle, the greater the output voltage value (Alfaris & Yuhendri, 2020). The maximum output voltage obtained in the test was 97.0 V, and the maximum duty cycle value was 77% because the MOSFET used only had a maximum V_{DS} specification of 100 V. The frequency used in this research was 25,000 Hz.

Data Collection

Data collection was carried out by varying the boost converter inductor using diameters of 0.5 mm, 1 mm, and 1.5 mm with 60 turns. Data collection was carried out by varying the duty cycle and light intensity. In the journal (Alfaris & Yuhendri, 2020; Hardian et al., 2025; Pauzi et al., 2020) it is stated that the greater the duty cycle, the greater the output voltage value will be.

Table 5. 0.5 mm Diameter Inductor Using 60 Turns

Light Intensity (LUX)	Frequency (Hz)	Duty Cycle (%)	Vin (V)	Iin (A)	Pin (W)	Vout (V)	Iout (A)	Pout (W)	Efficiency (%)
37,060	25,000	10%	19.5	0.28	5.46	19.9	0.15	2.98	54.67
42,820	25,000	20%	19.6	0.34	6.66	22.6	0.17	3.84	57.65
46,170	25,000	30%	19.8	0.46	9.10	26.6	0.21	5.58	61.33
69,230	25,000	40%	20.1	0.61	12.2	31.6	0.26	8.21	67.00
65,350	25,000	50%	20.0	0.90	18.0	37.9	0.32	12.1	67.37
61,070	25,000	60%	19.8	1.40	27.7	45.1	0.42	18.9	68.33

Table 6. 1 mm Diameter Inductor Using 60 Turns

Light Intensity (LUX)	Frequency (Hz)	Duty Cycle (%)	Vin (V)	Iin (A)	Pin (W)	Vout (V)	Iout (A)	Pout (W)	Efficiency (%)
37,060	25,000	10%	19.8	0.29	5.74	20.1	0.17	3.41	59.50
42,820	25,000	20%	19.9	0.35	6.96	23.1	0.18	4.15	59.69
46,170	25,000	30%	20.0	0.48	9.60	27.8	0.22	6.11	63.70
69,230	25,000	40%	20.3	0.62	12.5	31.7	0.27	8.55	68.00
65,350	25,000	50%	20.2	0.91	18.3	38.1	0.33	12.5	68.39
61,070	25,000	60%	20.1	1.41	28.3	45.7	0.45	20.5	72.56

Table 7. 1.5 mm Diameter Inductor Using 60 Turns

Light Intensity (LUX)	Frequency (Hz)	Duty Cycle (%)	Vin (V)	Iin (A)	Pin (W)	Vout (V)	Iout (A)	Pout (W)	Efficiency (%)
37,060	25,000	10%	19.8	0.30	5.94	20.4	0.17	3.46	58.38
42,820	25,000	20%	19.9	0.37	7.36	23.6	0.19	4.48	60.89
46,170	25,000	30%	19.9	0.44	8.75	28.0	0.24	6.72	76.74
69,230	25,000	40%	20.1	0.63	12.6	31.8	0.28	8.90	70.31
65,350	25,000	50%	20.0	0.91	18.2	39.1	0.34	13.2	73.04
61,070	25,000	60%	20.0	1.43	28.6	46.6	0.46	21.4	74.95

The switching MOSFET operates at a frequency of 25 KHz, with an output capacitor of 100 μF, a load of 102 Ω, and light intensity that varies according to environmental conditions. The duty cycle occurs when there is a comparison of the time when the MOSFET signal reaches the ON and OFF conditions in one signal period (Hardian et al., 2025).

The above data was collected simultaneously in order to obtain the same light intensity values for each diameter parameter used. In this test, an inductor with 60 turns was used and the diameter of the inductor was varied.

The selection of these values was based on the results of previous research (Hardian et al., 2025), which showed that the 60-turn configuration had the best performance compared to other turn variations.

Discussion

The effect of duty cycle and diameter variations of 0.5 mm, 1 mm, and 1.5 mm on voltage in a boost converter

Figure 5 shows the phenomenon of output voltage (V_{out}) increase in the boost converter in this research. This phenomenon is in accordance with the basic principle of a boost converter, which is to increase low output voltage (V_{out}) and eliminate voltage fluctuations in the solar panel output. A boost converter can increase the output voltage (V_{out}) to a higher level without having to eliminate excess power in the solar panel (Shaw, 2019). The increase in the output voltage (V_{out}) of the boost converter is influenced by the duty cycle. The greater the duty cycle, the greater the output voltage (V_{out}) produced (Assyidiq et al., n.d.; Marahatta et al., 2022).

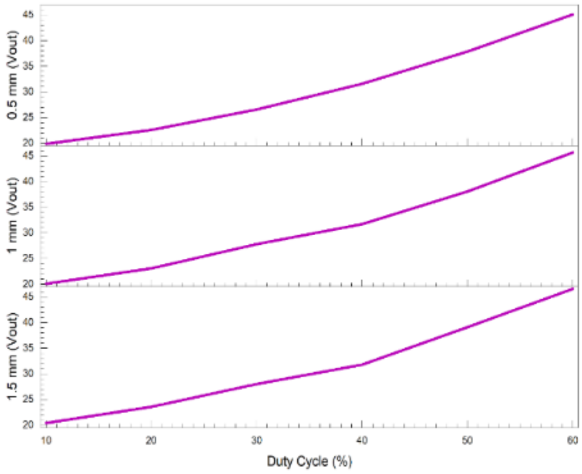

Figure 5. Voltage Rise Phenomenon (V_{out}) Against Duty Cycle

The voltage increase in a boost converter occurs due to the MOSFET switching process and energy conversion within the inductor (Hardian et al., 2025). When the MOSFET switch is in the ON (DT) state, the duty cycle (D) will affect the length of time the MOSFET gate is closed, so that the input current (I_{in}) stored in the inductor will increase and produce a larger output voltage (V_{out}) than the input voltage (V_{in}) (Assyidiq et al., n.d.; Hardian et al., 2025; Marahatta et al., 2022).

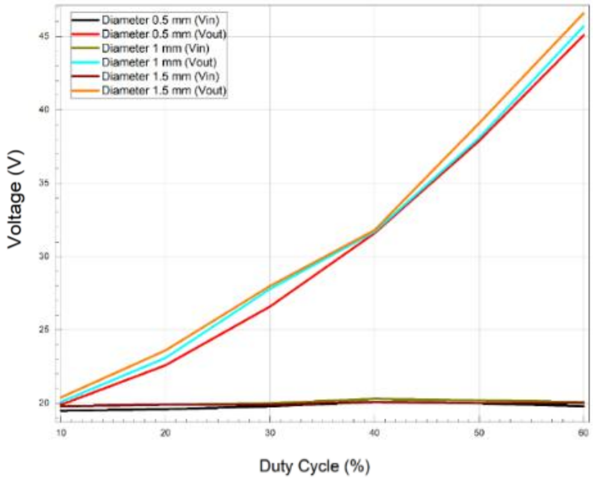

Figure 6. Graph of the Relationship between Voltage (Vin & Vout) and Inductor Diameter

An increase in the duty cycle value will extend the time the MOSFET is in the ON or closed state, so that the input current (I_{in}) stored in the inductor will increase, resulting in a greater output voltage when the MOSFET is OFF.

In general, the larger the wire diameter, the smaller the series resistance value of the inductor wire used (Assyidiq et al., n.d.; Hardian et al., 2025; Marahatta et al., 2022). Thus, the power loss generated will be smaller and the output voltage (V_{out}) will be more stable and higher.

Figure 6 shows the relationship between the duty cycle and the input voltage (V_{in}) and output voltage (V_{out}) in a boost converter with inductor wire diameters varying between 0.5 mm, 1 mm, and 1.5 mm. The graph shows that the diameter of the inductor wire affects the output voltage (V_{out}) of the boost converter. An inductor with a wire diameter of 1.5 mm produces a higher output voltage (V_{out}) than those with diameters of 0.5 mm and 1 mm with the same duty cycle value.

The effect of duty cycle and diameter variations of 0.5 mm, 1 mm, and 1.5 mm on current in a boost converter

The increase in current in a boost circuit is influenced by several factors, namely the length of time the switch is in the ON state, when the switch is in the OFF state, series resistance (R), and the inductor's ability to store current (IL). When the switch is in the ON state (DT), energy is stored in the inductor and magnetization occurs. The greater the ON duty cycle (DT), the more current will flow through and be stored in the inductor (Hardian et al., 2025).

Figure 7 shows the effect of duty cycle on input current (I_{in}) in the boost converter that has been created. The graph above shows that input current (I_{in}) will increase as the duty cycle value increases.

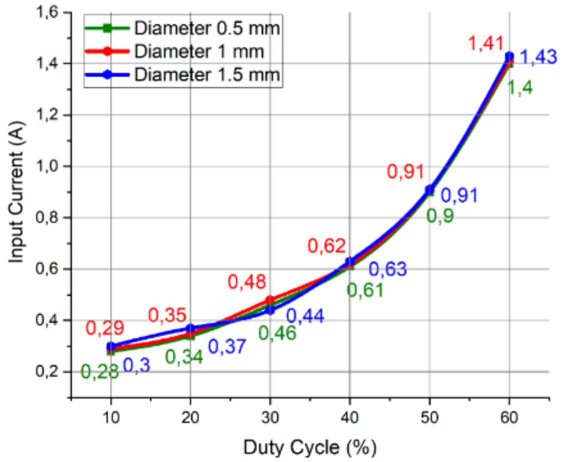

Figure 7. Graph of Duty Cycle Effect on Input Current (Iin)

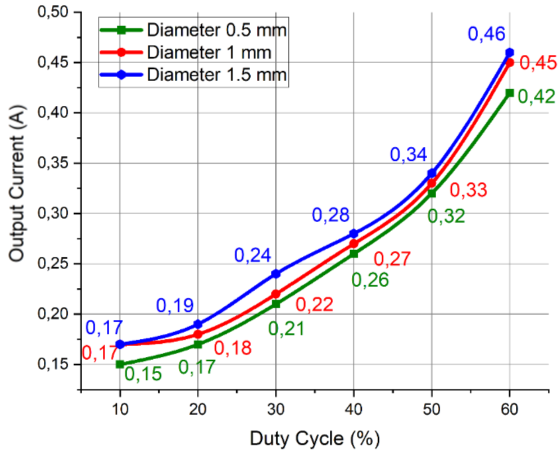

Figure 8. Graph of Duty Cycle Effect on Output Current (I_{out})

From the graph in Figure 8, it can be seen that of the three inductor parameters used, the output current (I_{out}) value will increase gradually as the duty cycle increases. The 1.5 mm diameter has the smallest series resistance and the best current storage capacity (IL) compared to other diameters. In the graph, as the duty cycle value increases, it can be seen that the 1.5 mm diameter produces the most significant increase in output current.

Increasing the wire diameter can reduce internal resistance in the inductor, thereby reducing power losses and allowing greater current transfer to the output side. This shows that wire diameter affects current conduction capacity as the duty cycle increases.

Efficiency of boost converters

In research (Hardian et al., 2025; Koç et al., 2022; Lopez-Santos, 2020; Vishwanatha & Yogesh V. Hote, 2017), it is stated that the condition of the components used greatly affects the performance of the boost converter. The efficiency of a boost converter is influenced by factors such as inductor inductance (L), inductor series resistance (R), MOSFET switching process, power losses in the inductor and MOSFET, average inductor current (IL), frequency (Hz), current ripple (ΔI_L), and CCM or DCM operating conditions.

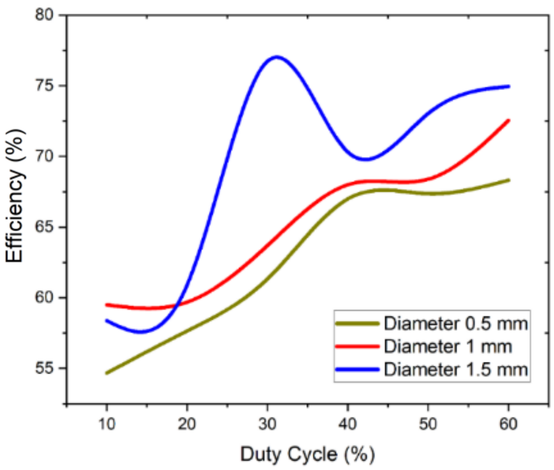

Figure 9. Graph showing the relationship between duty cycle and inductor diameter in relation to boost converter efficiency

Inductors play an important role in energy storage and transfer processes, and determine the operating mode characteristics of converters under CCM or DCM conditions. These operating modes affect efficiency, current and voltage ripple, and overall system stability. Power losses during inductor operation cause temperature increases that limit its size and energy density storage capacity (Barrios et al., 2021; Gozim et al., 2015).

The graph in Figure 9. shows the relationship between duty cycle and power conversion efficiency in a boost converter with three variations in inductor wire diameter. Inductor diameter greatly affects the optimization of boost converter performance, especially when the duty cycle increases.

An inductor with a wire diameter of 1.5 mm achieves a significant increase in efficiency. This phenomenon shows that a larger wire diameter with lower resistive resistance can reduce power losses due to heating and wire resistance, thereby providing optimal boost converter performance. Calculations (8), (9), (10), (11), (12), and (13) below are calculations of resistance and inductance for variations in inductor wire diameter.

1. Diameter variation of 0.5 mm

$$R = \frac{1.68\ x\ 10^{-8}\ x\ 7.32}{0.196\ x\ 10^{-6}} = 0.627\ \Omega \quad (8)$$

$$L = \frac{60^2 x\ 4\pi\ x\ 10^{-7} x\ 2000\ x\ 220\ x\ 10^{-6}}{0.122} \quad (9)$$

$$L = 0.01630\ H$$

2. Diameter variation of 1 mm

$$R = \frac{1.68\ x\ 10^{-8}\ x\ 7.32}{0.785\ x\ 10^{-6}} = 0.156\ \Omega \quad (10)$$

$$L = \frac{60^2 x\ 4\pi\ x\ 10^{-7} x\ 2000\ x\ 220\ x\ 10^{-6}}{0.122} \quad (11)$$

$$L = 0.01630\ H$$

3. Diameter variation of 1.5 mm

$$R = \frac{1.68\ x\ 10^{-8}\ x\ 7.32}{1.766\ x\ 10^{-6}} = 0.069\ \Omega \quad (12)$$

$$L = \frac{60^2 x\ 4\pi\ x\ 10^{-7} x\ 2000\ x\ 220\ x\ 10^{-6}}{0.122} \quad (13)$$

$$L = 0.01630\ H$$

In addition, boost converters in continuous conduction mode (CCM) will achieve higher efficiency compared to discontinuous conduction mode (DCM) (Mohamed & Ayad Bastawrous, 2020). In CCM, the inductor current never drops to zero during a switching cycle, which generally results in higher efficiency and lower current ripple (Laksono et al., 2018). Below are calculations of current ripple, average current, minimum current, and maximum current that occur in the inductor.

1. Diameter variation of 0.5 mm

$$\Delta I_L = \frac{0.3\ X\ 19.8}{0.01630\ x\ 25{,}000} = 0.0145\ A \quad (14)$$

$$I_L = \frac{0.21}{1-0.3} = 0.3\ A \quad (15)$$

$$IL_{min} = 0.3 - \frac{0.0145}{2} = 0.292\ A \quad (16)$$

$$IL_{max} = 0.3 + \frac{0.0145}{2} = 0.307\ A \quad (17)$$

2. Diameter variation of 1 mm

$$\Delta I_L = \frac{0.3\ X\ 20}{0.01630\ x\ 25{,}000} = 0.0147\ A \quad (18)$$

$$I_L = \frac{0.22}{1-0.3} = 0.31\ A \quad (19)$$

$$IL_{min} = 0.31 - \frac{0.0147}{2} = 0.302\ A \quad (20)$$

$$IL_{max} = 0.31 + \frac{0.0147}{2} = 0.317\ A \quad (21)$$

3. Diameter variation of 1.5 mm

$$\Delta I_L = \frac{0.3\ X\ 19.9}{0.01630\ x\ 25{,}000} = 0.0146\ A \quad (22)$$

$$I_L = \frac{0.24}{1-0.3} = 0.34\ A \quad (23)$$

$$IL_{min} = 0.34 - \frac{0.0146}{2} = 0.332\ A \quad (24)$$

$$IL_{max} = 0.34 + \frac{0.0146}{2} = 0.347\ A \quad (25)$$

From the above calculations, it can be seen that the boost converter in this research operates in continuous current mode (CCM). Continuous current mode (CCM) operates when $IL_{min} > 0$ (Assyidiq et al., n.d.; Gozim et al., 2015; Mahmood & Selman, 2016). From calculations (14-25), we obtain ripple currents and currents stored in inductors with different values. An inductor with a diameter of 0.5 mm obtains the lowest ripple current of 0.0145 A and has the lowest current storage capacity, with an average current of 0.3 A.

Meanwhile, the 1.5 mm diameter inductor obtained the highest current ripple of 0.0146 A, but had the best current storage capacity with an average current of 0.34 A. This will greatly affect the inductor in overcoming the magnitude of the existing current ripple, which will affect the voltage conversion in the boost converter. (ΔI_L) is the current ripple generated when the MOSFET is in the ON state.

When the switch is active for a long period of time (Switch ON), conduction losses will increase, high current ripples will occur, and the switch's operating cycle will be extreme. Parasitic components such as inductance values will limit the voltage gain that has been achieved (Koç et al., 2022; Lopez-Santos, 2020).

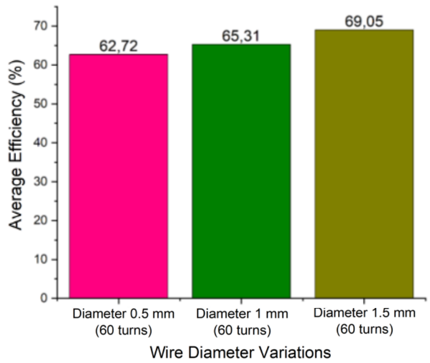

Figure 10. Average Efficiency of Inductor Diameter

The graph in Figure 10 shows the average efficiency for diameters of 0.5 mm, 1 mm, and 1.5 mm using 60 turns. The 1.5 mm diameter has the highest average efficiency, enabling the boost converter to operate optimally. This is because the 1.5 mm diameter can store more current (IL) than the other diameters. In addition, the 1.5 mm diameter also has lower series resistance (R), which reduces power losses and converts stored energy efficiently.

CONCLUSION

Based on the research results obtained, a diameter of 1.5 mm achieved the most optimal performance with an efficiency of 69.05%. The size of the inductor greatly affects the performance of the boost converter in order to achieve optimal performance. An inductor with a diameter of 0.5 mm obtains the lowest ripple current of 0.0145 A and has the lowest current storage capacity, with an average current of 0.3 A.

Meanwhile, the 1.5 mm diameter inductor obtained the highest current ripple of 0.0146 A, but had the best current storage capacity with an average current of 0.34 A. This will greatly affect the inductor in overcoming the magnitude of the existing current ripple, which will affect the voltage conversion in the boost converter. (ΔI_L) is the current ripple generated when the MOSFET is in the ON state.

When the switch is active for a long period of time (Switch ON), conduction losses will increase, high current ripples will occur, and the switch's operating cycle will be extreme. Increasing the diameter of the inductor will improve its ability to store current (IL) and reduce internal resistance, thereby overcoming large current ripple (ΔI_L), reducing power losses due to heat, and converting energy efficiently. A diameter of 1.5 mm can store more current (IL) than other diameters. In addition, a diameter of 1.5 mm also has lower series resistance (R), thereby minimizing power losses and converting stored energy efficiently.

For further research, it is recommended to develop further improvements related to increasing the efficiency of the boost converter by using double inductors or signal modulation techniques.

REFERENCES

Alfaris, A., & Yuhendri, M. (2020). Sistem Kendali dan Monitoring Boost Converter Berbasis GUI (graphical user interface) Matlab Menggunakan Arduino. *JTEIN: Jurnal Teknik Elektro Indonesia*, *1*(2), 266–272. https://doi.org/10.24036/jtein.v1i2.83

Anshory, I., Jamaaluddin, J., Wisaksono, A., Sulistiyowati, I., Hindarto, Rintyarna, B. S., Fudholi, A., Rahman, Y. A., & Sopian, K. (2024). Optimization DC-DC boost converter of BLDC motor drive by solar panel using PID and firefly algorithm. *Results in Engineering*, *21*(March 2023), 101727. https://doi.org/10.1016/j.rineng.2023.101727

Assyidiq, M. A., Winardi, B., & Andromeda, T. (n.d.). *Perancangan Boost Converter Menggunakan Voltage Feedback Pada Panel Surya*.

Barrios, E. L., Elizondo, D., Ursua, A., & Sanchis, P. (2021). Winding Resistance Measurement in Power Inductors - Understanding the Impact of the Winding Mutual Resistance. *IEEE Access*, *9*, 92224–92238. https://doi.org/10.1109/ACCESS.2021.3092887

Gozim, D., Guesmi, K., & Mahi, D. (2015). Experimental study of the boost converter under current mode control. *International Journal of Power Electronics and Drive Systems*, *6*(3), 586–593. https://doi.org/10.11591/ijpeds.v6.i3.pp586-595

Hardian, M. P. A., Fatwa, G., & Erlangga, A. (2025). *Design And Performance Analysis of a Solar-Powered Boost Converter with Inductor Variations Controlled by Arduino Uno*. *11*(1).

Hauke, B. (2009). Basic Calculation of a Boost Converter's Power Stage. *Texas Instruments, Application Report November*, *November 2009*, 1–9. http://scholar.google.com/scholar?hl=

en&btnG=Search&q=intitle:Basic+Calculation+of+a+Boost+Converter's+Power+Stage#0

Koç, Y., Birbir, Y., & Bodur, H. (2022). Non-isolated high step-up DC/DC converters – An overview. *Alexandria Engineering Journal*, *61*(2), 1091–1132. https://doi.org/10.1016/j.aej.2021.06.071

Laksono, T. U., Andromeda, T., & Winardi, B. (2018). Pengaruh Variasi Induktor Terhadap Hasil Operasi Ccm Dan Dcm Dc Chopper Tipe Zeta Berbasis Ic Tl494. *Transient*, *7*(1), 1. https://doi.org/10.14710/transient.7.1.1-7

Lopez-Santos, J. C. M.-M. J. C. R.-C. O. (2020). *IET Power Electronics - 2020 - Lopez-Santos - Quadratic boost converter with low-output-voltage ripple.pdf* (p. Vol. 13 Iss. 8, pp. 1605–1612). IET Power Electron © The Institution of Engineering and Technology.

Mahardhika Harilinawan, & M. Y. (2024). *Strategi industrialisasi: Hubungan dengan sektor lain*. Jurnal Ekonomi Dan Pembangunan Indonesia. https://doi.org/10.61132/jepi.v2i3.654

Mahmood, J. R., & Selman, N. H. (2016). Control of the Output Voltage of the PV System Based DC-DC Boost Converter Using Arduino microcontroller 1. *International Journal of Science Engineering and Advance Technology, IJSEAT*, *4*(7). www.ijseat.com

Marahatta, A., Rajbhandari, Y., Shrestha, A., Phuyal, S., Thapa, A., & Korba, P. (2022). Model predictive control of DC/DC boost converter with reinforcement learning. *Heliyon*, *8*(11), e11416. https://doi.org/10.1016/j.heliyon.2022.e11416

Mohamed, A. K., & Ayad Bastawrous, H. (2020). Analysis and Design of an Improved Single Switch Quadratic DC/DC Converter for Continuous Conduction Mode (CCM) Operation in Renewable Energy Systems. *PECon 2020 - 2020 IEEE International Conference on Power and Energy*, *Ccm*, 148–152. https://doi.org/10.1109/PECon48942.2020.9314545

Pauzi, G. A., Rahma, D., Suciyati, S. W., & Surtono, A. (2020). Rancang Bangun Prototipe Pengoptimal Charging Baterai pada Mobil Listrik dari Pembangkit Tenaga Surya dengan Menggunakan Sistem Boost Converter. *Journal of Energy, Material, and Instrumentation Technology*, *1*(2), 40–46. https://doi.org/10.23960/jemit.v1i2.19

Raj, A., & Praveen, R. P. (2022). Highly efficient DC-DC boost converter implemented with improved MPPT algorithm for utility level photovoltaic applications. *Ain Shams Engineering Journal*, *13*(3), 101617. https://doi.org/10.1016/j.asej.2021.10.012

Shaw, P. (2019). Modelling and analysis of an analogue MPPT-based PV battery charging system utilising DC-DC boost converter. *IET Renewable Power Generation*, *13*(11), 1958–1967. https://doi.org/10.1049/iet-rpg.2018.6273

Srija, D. K., Keerthi, T. S., Anusha, R., Chandana, B. H., & Peddapati, S. (2019). Performance analysis of non-isolated high step-up DC-DC converter topologies used in photovoltaic grid connected electric vehicle charging stations. *5th International Conference on Electrical Energy Systems, ICEES 2019*, 1–6. https://doi.org/10.1109/ICEES.2019.8719288

Vishwanatha, S., & Yogesh V. Hote. (2017). *IET Circuits Devices Syst - 2017 - Siddhartha - Systematic circuit design and analysis of a non-ideal DC DC pulse width.pdf.* 12(2),144–156.