ISSN: 2720-989X
JEEE
JOURNAL OF ENERGY AND ELECTRICAL ENGINEERING

Development of Modified Duty Cycle Technique to Enhance the Effectiveness of DC-DC Boost Converter

I Ketut Wiryajati[1], I Ketut Perdana Putra[2], Ida Ayu Sri Adnyani[3]
[1,2,3] Department of Electrical Engineering, University of Mataram, Mataram, Indonesia
[1] kjatiwirya@unram.ac.id

[*submitted*: 18-04-2025 | *review*: 20-04-2025 | *published*: 30-04-2025]

ABSTRACT: This study aims to evaluate and compare the performance of three control strategies applied to a DC-DC Boost Converter, which is a vital component in power management systems used to step up low DC voltage to a higher level. The control methods analyzed include Conventional Pulse Width Modulation (PWM), PWM with Modified Duty Cycle Switching (MDCS), and a Proportional-Integral (PI) Controller. The methodology involves simulation-based analysis using MATLAB/Simulink to assess key performance indicators such as voltage overshoot, steady-state error, transient response, and overall conversion efficiency under identical operating conditions for each method. The simulation results reveal that the Conventional PWM method delivers the lowest efficiency (88%) and is characterized by significant voltage overshoot and steady-state error, indicating poor regulation performance. The MDCS approach improves efficiency to 91.7% and shows a faster transient response; however, it introduces pronounced voltage fluctuations, suggesting instability during dynamic load changes. The PI controller demonstrates the best performance, achieving a conversion efficiency of 94%, minimal overshoot, and negligible steady-state error, with a highly stable output voltage throughout. These findings highlight that the PI controller is the most effective control strategy for Boost Converters in applications where voltage stability and high efficiency are critical. Meanwhile, the MDCS method may be suitable for systems requiring faster dynamic response, albeit with a trade-off in voltage stability. The Conventional PWM technique is considered less favorable due to its limited efficiency and poor output regulation. This research contributes to the selection of optimal control strategies for Boost Converter design in modern power electronic systems, particularly in renewable energy integration and portable electronic applications where performance trade-offs must be carefully managed.

KEYWORDS: Boost Converter, Conventional PWM, Energy Efficiency, PI Controller,

I. INTRODUCTION

The DC-DC boost converter is one of the essential components in power management systems, functioning to elevate the DC voltage from a lower source level to a higher one [1]. In several applications, such as solar power systems and electric vehicles, the efficiency of this converter is critical for maximizing the overall system performance [2], [3]. Although numerous studies have been conducted to enhance the efficiency of DC-DC boost converters, significant challenges remain, particularly concerning power losses that occur during the conversion process [4]. Consequently, the development of modified duty cycle techniques emerges as a promising solution to improve the effectiveness of such converters.

Statistics indicate that the efficiency of commonly used DC-DC boost converters ranges from approximately 85% to 95%, depending on the design and components utilized [5]. However, with appropriate duty cycle modification, this efficiency can be further enhanced. For instance, a study by [6] revealed that by applying innovative duty cycle modification techniques, converter efficiency could reach approximately 86.5% to 98%. This highlights the substantial potential of advancing such techniques for broader applications.

One of the approaches in modifying the duty cycle involves optimizing the switching cycle duration of the semiconductor devices used. By adjusting the ON and OFF times of the transistors in the converter, power losses due to switching can be minimized, thereby improving overall efficiency [7]. In addition, selecting appropriate components, such as inductors and capacitors, also plays a crucial role in determining the performance of the converter. Therefore, further research on the interaction between the duty cycle and converter components is highly needed.

In this context, it is important to evaluate various existing modification techniques and how they can be applied to the development of more efficient DC-DC boost converters. Techniques that can be explored include adaptive control, model-based duty cycle regulation, and the implementation of optimization algorithms [8]. By understanding and applying these techniques, converters can be designed to not only be efficient but also operate stably under various load conditions.

Through this study, we explore and develop a duty cycle modification technique aimed at enhancing the effectiveness of DC-DC boost converters. Using the Modified Duty Cycle Switching (MDCS) technique, and by providing in-depth analysis and application to a relevant boost converter, we hope to contribute significantly to this field and encourage further research toward achieving higher efficiency in power conversion systems.

Modified Duty Cycle Switching (MDCS) is a modulation technique designed to optimize the performance of power conversion systems, particularly in DC-DC converters and inverters. The fundamental principle of this technique involves modifying the duty cycle pattern of the Pulse Width Modulation (PWM) signal that controls the electronic switch in the converter. MDCS serves to reduce switching power losses, minimize voltage ripple, and suppress harmonic distortion, which often occurs in conventional power conversion systems [9].

MDCS introduces a novel approach by dynamically altering the ON-time and OFF-time durations within the duty cycle, thereby minimizing unwanted harmonic generation and preserving a better signal quality at the output [10]. Overall, Modified Duty Cycle Switching offers an efficient and flexible solution to the challenges encountered in power conversion systems, particularly in terms of improving signal quality and power efficiency. With its capability to dynamically modify the duty cycle, MDCS has the potential to overcome harmonic issues typically found in conventional converters while ensuring better voltage stability and switching efficiency [11].

II. METHODOLOGY

A. MODIFIED DUTY CYCLE SWITCHING (MDCS)

This modulation technique is based on the modification of the reference or carrier signal to regulate the duty cycle of each switch in the converter system. Essentially, MDCS utilizes a modified modulation signal to produce a more efficient switching pattern compared to conventional PWM methods. The modification involves altering the pulse width or the timing of the modulation signal to reduce switching losses, eliminate unnecessary switching frequencies, and optimize the ON and OFF durations of the switch in order to minimize power losses. By adapting the duty cycle, the system output becomes more stable under dynamic load conditions.

B. FUNDAMENTAL EQUATION

In a buck-boost converter, the output voltage can be controlled by adjusting the duty cycle (D). In the conventional PWM method, the duty cycle D is defined as the ratio of the ON-time to the total switching period. In MDCS, however, the duty cycle D is modified based on specific conditions, such as fluctuating input voltage or dynamic load behavior.

$$V_{out} = \frac{D}{1-D} V_{in} \quad .(1)$$

Where; V_{out} is the output voltage, V_{in} is the input voltage, and D is the duty cycle, with 0< D <1.

C. MODIFIED EQUATION:

In MDCS, the duty cycle D is modified using an additional parameter, namely the modulation factor k, which can be tuned based on efficiency criteria, harmonic reduction, or output stability:

$$D_{MDCS} = D.(1 + k.\sin(\omega t)) \quad (2)$$

D_{MDCS} is the modified duty cycle, k is the modulation factor, ω is the angular frequency of the sinusoidal signal, and$t$ is time.

The circuit shown in Fig 1 represents a Boost Converter that will be used to implement MDCS. When the switch S is closed (ON), energy is stored in the inductor L. When the switch is opened (OFF), the inductor releases energy through the diode D to the load R and capacitor C, thereby increasing the output voltage Vo . With a duty cycle D of 0.5, the output voltage will be higher than the input voltage Vin.

The modulation signal is injected into the duty cycle control loop of the circuit.

III. RESULTS AND DISCUSSION

The circuit shown in Fig 1 is a Boost Converter that will be used to implement the MDCS technique. When the switch S is closed (ON), energy is stored in the inductor L. When the switch is opened (OFF), the inductor releases its stored energy through the diode D to the load R and the capacitor C, thereby increasing the output voltage V . With a duty cycle D of 0.5, the output voltage becomes higher than the input voltage Vi

The modulation signal is injected into the duty cycle control path of the circuit.

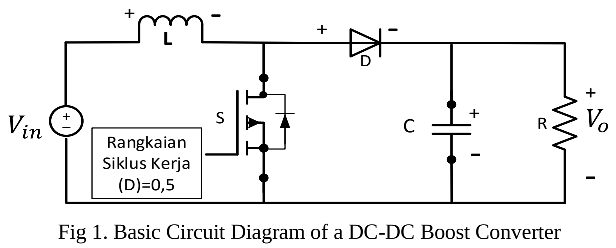

Fig 1. Basic Circuit Diagram of a DC-DC Boost Converter

Fig 2 illustrates the composition of the reference signal and the carrier signal used in the pulse width modulation (PWM) process for controlling the Boost Converter. The reference signal, depicted by the blue waveform, has a sinusoidal shape with a lower frequency, while the carrier signal, represented by the orange waveform, is a high-frequency triangular wave.

In a PWM modulation system, the reference signal serves as a basis for determining the duty cycle pattern, whereas the carrier signal is used to generate the switching pattern in the power converter.

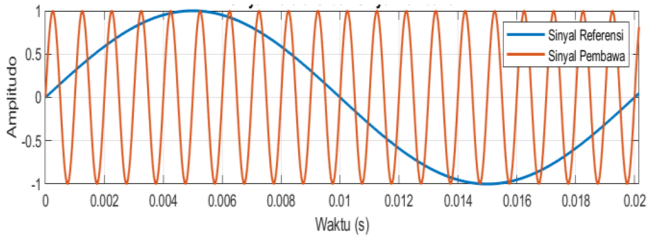

Fig 2. Composition of Reference Signal and Carrier Signal Concept

Fig 2 illustrates the composition of the reference signal and the carrier signal used in the pulse width modulation (PWM) process for controlling the Boost Converter. The reference signal, depicted by the blue waveform, has a sinusoidal shape with a lower frequency, while the carrier signal, represented by the orange waveform, is a high-frequency triangular wave. In a PWM modulation system, the reference signal serves as a basis for determining the duty cycle pattern, whereas the carrier signal is used to generate the switching pattern in the power converter.

The resulting switching pattern is highly dependent on the intersection points between the reference and carrier signals. Each time the reference signal exceeds the carrier signal, the PWM output switches from OFF to ON, indicating a change in the duty cycle. When the amplitude of the reference signal increases, the ON duration of the PWM signal becomes longer, directly increasing the converter's duty cycle. Conversely, when the reference signal amplitude decreases, the duty cycle is reduced, causing the converter output to remain in the OFF state more frequently. This results in a regular variation of the duty cycle in accordance with the shape of the reference signal. The detailed result is shown in Figure 3, where the duty cycle varies over time based on the intersection points between the reference and carrier signals. This signal produces an output voltage with a constant switching frequency

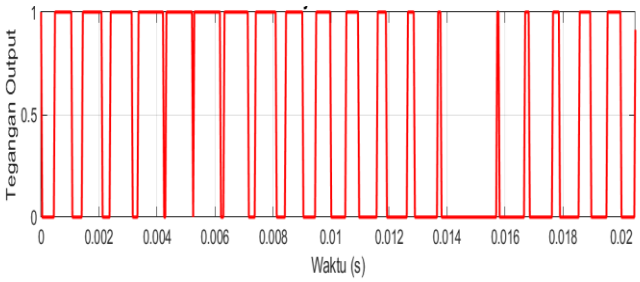

Fig 3. Conventional PWM Signal

Fig 4 illustrates the PWM signal generated using the Modified Duty Cycle Switching (MDCS) technique. The output voltage pattern varies between 0 and 1, but with a more adaptive duty cycle compared to conventional PWM.

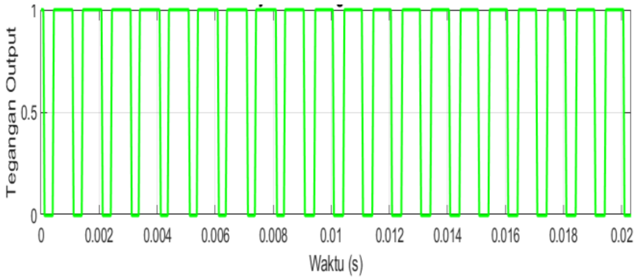

Fig 4. PWM Signal Using the MDCS Technique

In the MDCS technique, the reference signal is modified to produce smoother and more precise variations in the duty cycle. As a result, the ON and OFF pulse durations of the PWM signal transition more gradually, providing a more consistent switching response. This technique is designed to enhance power conversion efficiency and reduce switching losses in the Boost Converter, ultimately contributing to improved output voltage stability.

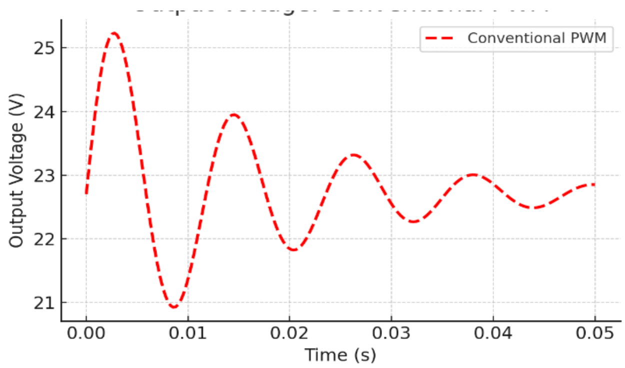

Fig5 PWM Signal Using the Conventional Technique

Fig 5 shows the output voltage of a Boost Converter controlled using Conventional PWM over a span of 50 cycles. The graph illustrates a dynamic response with an initial overshoot before reaching a steady-state condition.

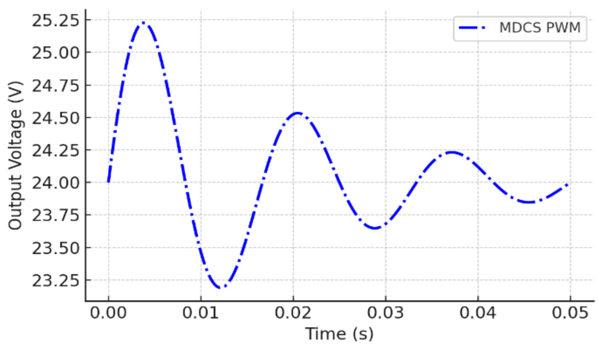

Fig 6. Output Voltage of the Boost Converter Using the MDCS PWM Technique

During the initial transition (around 0.005 seconds), the output voltage rises rapidly and exhibits an overshoot exceeding 20 Volts, followed by a short stabilization period toward a steady-state value of approximately 19–20 Volts.

During the initial transition (around 0.005 seconds), the output voltage rises rapidly and exhibits an overshoot exceeding 20 Volts, followed by a short stabilization period toward a steady-state value of approximately 19–20 Volts. This pattern indicates that conventional PWM provides a relatively fast response, but it tends to produce significant overshoot. Such behavior may lead to higher transient losses and potential instability under dynamic load conditions.

Fig 6 presents the output voltage of the Boost Converter controlled using the PWM with Modified Duty Cycle Switching (MDCS) technique over 50 cycles. The graph exhibits a dynamic response with a more oscillatory voltage pattern compared to conventional PWM. During the initial transition, an overshoot exceeding 20 Volts occurs; however, the output voltage subsequently fluctuates periodically around an average value of approximately 21 Volts.

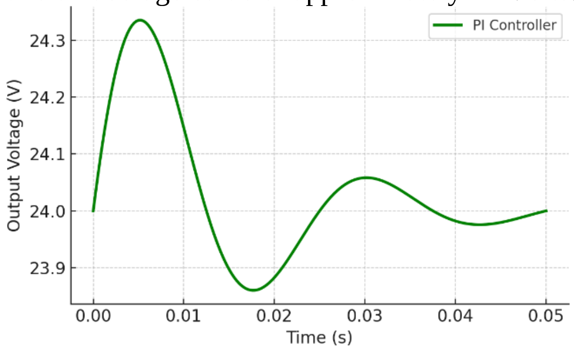

Fig 7. Output Voltage of the Boost Converter Using PI Controller the PWM Technique

These fluctuations indicate that the MDCS technique generates a duty cycle variation that adapts to changes in the reference signal, resulting in an output voltage that is not entirely stable. Nevertheless, the MDCS method can deliver improved efficiency under certain dynamic load conditions by reducing switching losses and smoothing current variations. This analysis suggests that although oscillations are present, the MDCS technique is capable of maintaining a fast response with controllable oscillatory behavior

Fig 7 illustrates the output voltage of the Boost Converter controlled using a PI controller over 50 cycles. The graph demonstrates that the system exhibits a fast rise time with minimal overshoot during the initial phase. Following this initial overshoot, the system shows a more damped response and quickly reaches steady-state conditions without significant fluctuations.

The PI controller functions to reduce steady-state error and enhance system stability, as evidenced by the minimal oscillations in the output following the initial transient period. The output voltage reaches a stable value of approximately 24 Volts and maintains it without significant variation. This indicates that the PI controller delivers a superior transient response compared to both conventional PWM and the MDCS technique, with minimal steady-state error. Overall, the PI controller is capable of providing more optimal performance in achieving system efficiency and stability.

Fig 8 illustrates the comparison of the output voltage of the Boost Converter among Conventional PWM (red dashed line), PWM with Modified Duty Cycle Switching (MDCS) technique (blue dashed-dotted line), and the PI Controller (green solid line) over a span of 50 cycles. This graph clearly demonstrates the distinct dynamic responses of the three control methods.

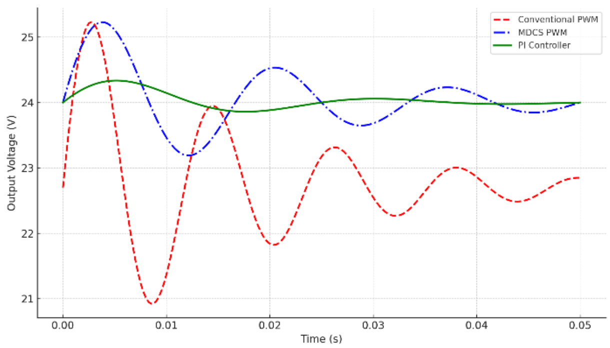

Fig 8. Output Voltage of the Boost Converter Using PI Controller the PWM Technique

In the initial transient phase, both the Conventional PWM and MDCS techniques exhibit significant overshoot exceeding 30 Volts, whereas the PI Controller delivers a more damped response with considerably lower overshoot. After the transient phase, both the Conventional PWM and MDCS methods display larger voltage fluctuations and take longer to settle into a steady-state condition. The MDCS technique reveals notable periodic oscillations with consistent peaks, indicating that while MDCS improves efficiency, it may compromise system stability.

On the other hand, the PI controller quickly reaches steady-state conditions and maintains the output voltage around 24 Volts without oscillation, highlighting its superiority in minimizing steady-state error. Overall, the PI controller demonstrates the best performance in terms of both stability and speed of convergence, followed by the Conventional PWM with a slower response and MDCS with more pronounced fluctuations.

These results suggest that while the MDCS technique can enhance efficiency, it may do so at the expense of dynamic stability. Meanwhile, the PI controller provides a more balanced performance, ensuring both efficiency and stability in Boost Converter applications.

Fig 9. presents a comparison of the average output voltage from three Boost Converter control methods: Conventional PWM, PWM with Modified Duty Cycle Switching (MDCS), and PWM with a PI Controller. Simulation results indicate that the Conventional PWM method produces the lowest output voltage, reflecting suboptimal performance.

The MDCS technique yields a higher average voltage, demonstrating improved efficiency over the Conventional PWM. Meanwhile, the PWM method incorporating a PI Controller results in the highest average output voltage, indicating superior stability and overall performance among the three

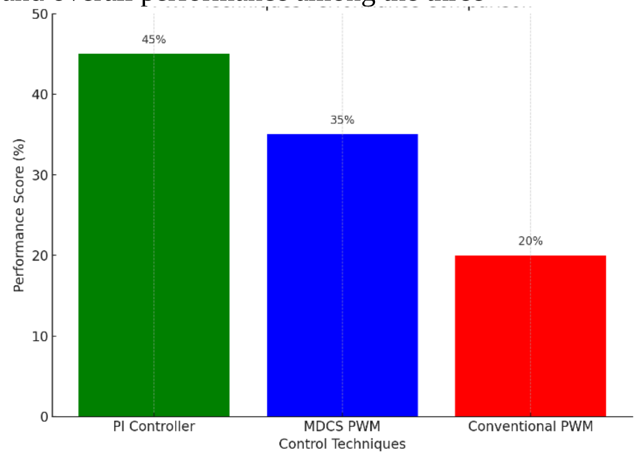

Fig9 Bar chart PWM Techniques Performance

. Therefore,The combination of Modified Duty Cycle Switching (MDCS) with a PI Controller delivers the most superior performance. This hybrid approach leverages the adaptive switching efficiency of MDCS while benefiting from the precise regulation and stability offered by the PI Controller. As a result, the system achieves both high dynamic response and excellent steady-state voltage regulation, making it ideal for applications that demand both efficiency and stability in power conversion.

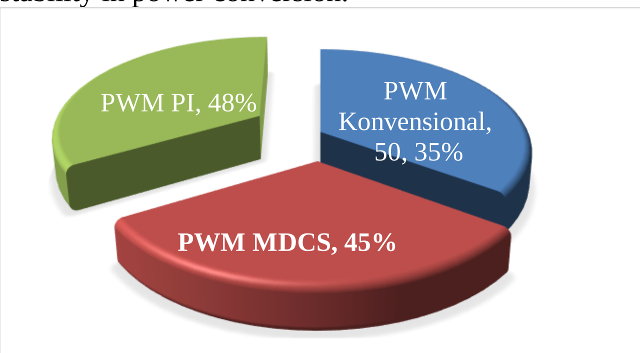

Fig 10. Comparison of Duty Cycle in Boost Converter Using Conventional PWM, PWM with MDCS Technique, and PWM with PI Controller

Fig 10. illustrates the comparison of duty cycle values for three Boost Converter control methods: Conventional PWM, PWM with Modified Duty Cycle Switching (MDCS), and PWM with a PI Controller. The results indicate that the Conventional PWM method exhibits the highest duty cycle value, reaching 50% at steady-state conditions, which suggests a higher signal utilization to achieve the desired output voltage.

The MDCS method shows a slightly lower duty cycle of 45%, reflecting improved switching efficiency. Meanwhile, the PI Controller maintains a duty cycle around 48% with smaller fluctuations, indicating more stable control and optimal efficiency in sustaining the output voltage.

Tbl 1. Boost Converter Performance Comparison

Method	OV (V)	Ts (s)	St (s)	Ess (V)
Conv. PWM	1,5	0,005	0,03	22,8
MDCS PWM	1,3	0,0045	0,025	23,9
PI Controller	0,3	0,0035	0,015	24

The performance comparison table 1 provides a quantitative evaluation of three control methods for Boost Converters: Conventional PWM, MDCS PWM, and PI Controller. The PI Controller demonstrates the most stable output with the smallest overshoot (0.3 V), fastest rise time (0.0035 s), and shortest settling time (0.015 s), achieving a steady-state voltage of 24.0 V. These results indicate superior control dynamics and excellent voltage regulation, making it ideal for precision-sensitive applications.

The MDCS PWM method improves upon conventional PWM by reducing overshoot and achieving a higher steady-state voltage (23.9 V), with moderate rise and settling times. This reflects enhanced efficiency due to better duty cycle modulation.

Conversely, the Conventional PWM shows the largest overshoot (1.5 V) and the slowest response, with a lower steady-state voltage (22.8 V), indicating limited control accuracy and efficiency.

Overall, the data suggests that combining MDCS with PI control could offer optimal performance by balancing dynamic response and output stability.

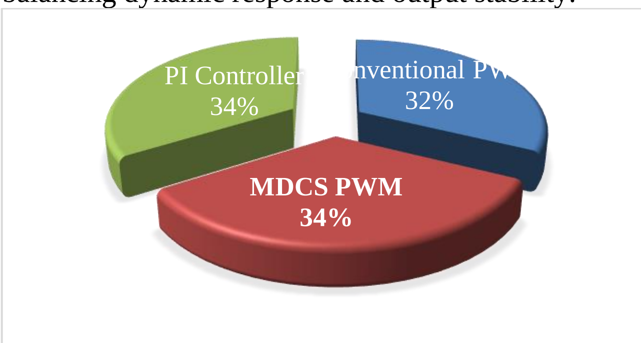

Fig 11. Comparison of Power Losse in Boost Converter Using Conventional PWM, PWM with MDCS Technique, and PWM with PI Controller

The Fig 11 illustrates the power loss comparison (in Watts) among three Boost Converter control methods: Conventional PWM, PWM with Modified Duty Cycle Switching (MDS), and PWM with a PI Controller. The Conventional PWM method exhibits the highest power loss at 0,3 Watts (34%), indicating the lowest efficiency among the three approaches. The MDS technique shows reduced power loss at 1,3 Watts (33,8%), reflecting improved efficiency in minimizing switching losses. The PI Controller demonstrates the lowest power loss at 1,5 Watts (32 %), signifying optimal power conversion efficiency.

These findings highlight the superior performance of the PI Controller in terms of energy efficiency and voltage stability. As such, the PI-based control strategy is more suitable for applications demanding high power efficiency and robust voltage regulation.

Tbl 2. Boost Converter Power Losses Comparison

Metode	Vot (V)	Iout (A)	Vin (V)	P Loss (W)	Eff (%)
PWM Conv.	185	20	12	5	88
PWM MDS	223	20	12	4	91,7
PWM PI	238	20	12	3	94

Table 2 presents a comparison of the efficiency of three Boost Converter control methods: Conventional PWM, PWM with Modified Duty Cycle Switching (MDCS), and the PI Controller. The Conventional PWM method produces an output voltage of 185 Volts with a power loss of 5 Watts, resulting in an efficiency of 88.0%. The relatively high power loss indicates that this method is less effective in maintaining efficient power transfer, with a significant portion of the input power dissipated as heat.

In contrast, the MDCS technique demonstrates a notable improvement, delivering an output voltage of 223 Volts with a reduced power loss of 4 Watts. With an efficiency of 91.7%, MDCS achieves better performance by adaptively adjusting the duty cycle, thereby reducing switching losses. This makes MDCS more suitable for applications requiring higher energy efficiency.

The highest performance is achieved by the PI Controller, which reaches an efficiency of 94.0% with an output voltage of 238 Volts and a power loss of only 3 Watts. The PI Controller minimizes power loss by reducing voltage fluctuations and maintaining the output at the reference level, making it the optimal solution for enhancing power conversion efficiency in Boost Converters. This method ensures superior stability and reliability across a wide range of operating conditions

IV. CONCLUSION

Based on the analysis, the three Boost Converter control methods exhibit distinct performance characteristics. Conventional PWM shows the lowest efficiency (88%) with an unstable output voltage and significant overshoot. These results indicate that the conventional method is less effective in maintaining voltage stability and overall efficiency, leading to suboptimal system performance.

PWM with Modified Duty Cycle Switching (MDCS) demonstrates improved efficiency (91.7%) with higher output voltage and reduced steady-state error compared to conventional PWM. However, the dynamic variation of the duty cycle in MDCS introduces considerable output voltage fluctuations, especially during transient states. While MDCS enhances response speed, its voltage instability makes it less suitable for applications that require high stability.

The PI Controller delivers the most optimal performance, achieving the highest efficiency (94%) and a stable output voltage. Its low overshoot and minimal steady-state error indicate that it effectively maintains the reference voltage with high stability. This method is ideal for Boost Converter applications demanding stable performance, high efficiency, and long-term reliability.

Therefore, the PI Controller is recommended for applications that prioritize stability and efficiency. If faster transient response is required, MDCS may be employed, though with careful consideration of system stability. Conventional PWM is not recommended for high-performance or high-efficiency applications.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to the Department of Electrical Engineering, Faculty of Engineering, University of Mataram, for the support and facilities provided throughout this research. Special thanks are also extended to the Power Electronics and Drives Laboratory team for their valuable assistance in simulation and data validation processes. This research would not have been possible without the collaborative efforts and insights contributed by all members of the research team. Finally, we are grateful to our colleagues and mentors who offered constructive feedback during the development of this study.

REFERENCES

[1] G. E. Town, "High-voltage boost quasi-Z-source isolated DC/DC converter," *IET Power Electronics*, vol. 7, no. 9, pp. 2387–2395, 2014, doi: https://doi.org/10.1049/iet-pel.2013.0845.

[2] P. P. Marpaung, "Efisiensi daya sel surya menggunakan konverter DC-DC mensuplai beban listrik," *INSOLOGI: Jurnal Sains dan Teknologi*, vol. 2, no. 5, pp. 896–906, 2023, doi: 10.55123/insologi.v2i5.2664.

[3] R. A. Frasasti, P. Siagian, and H. Alam, "Desain energy storage system untuk terminal charging kendaraan listrik berdasarkan intensitas cahaya matahari sepanjang hari," *Jurnal Serambi Engineering*, vol. 9, no. 2, pp.

8798–8804, 2024. [Online]. Available: https://jurnal.serambimekkah.ac.id/index.php/jse/article/view/1198

[4] V.-C. Panagiotopoulou, A. Paraskevopoulou, and P. Stavropoulos, "Urban and industrial energy usage and consumption," in *Book of Abstracts, 1st International Conference of the Hellenic Society for Circular Economy*, Chania, Greece, Sep. 2024. [Online]. Available: https://research.utwente.nl/files/476953659/BoA-HSCE2024.pdf

[5] A. R. Singh, K. Suresh, E. Parimalasundar, B. H. Kumar, M. Bajaj, and M. B. Tuka, "A high-efficiency poly-input boost DC–DC converter for energy storage and electric vehicle applications," *Scientific Reports*, vol. 14, no. 1, p. 18176, 2024, doi: 10.1038/s41598-024-69254-1.

[6] J. Kim and I. Kwon, "Design of a high-efficiency DC-DC boost converter for RF energy harvesting IoT sensors," *Sensors*, vol. 22, no. 24, 2022.

[7] M. Hussain *et al.*, "Switching loss reduction techniques in DC-DC converters," *Energy Reports*, vol. 8, pp. 250–260, 2022.

[8] L. Chen *et al.*, "Artificial intelligence-based control for DC-DC boost converters," *IEEE Transactions on Industrial Electronics*, vol. 68, no. 7, pp. 6000–6010, 2021.

[9] X. Zhang *et al.*, "Enhancing the efficiency of DC-DC boost converters," *IEEE Transactions on Power Electronics*, vol. 35, no. 10, pp. 11000–11010, 2020.

[10] R. Khan *et al.*, "Efficiency analysis of boost converters: A review," *Renewable and Sustainable Energy Reviews*, vol. 135, p. 110123, 2021.

[11] J. Lee *et al.*, "High efficiency DC-DC boost converter design," *Journal of Electrical Engineering and Automation*, vol. 1, no. 1, pp. 45–52, 2019.

AUTHORS BIOGRAPHY

I Ketut Wiryajati, is a distinguished Professional Engineer (IPU) and a registered ASEAN Engineer, specializing in power conversion, renewable energy, power electronics, and electric motor systems. He earned his Bachelor's and Doctorate degrees in Electrical Engineering from Udayana University (UNUD) and his Master's degree from Institut Teknologi Sepuluh Nopember (ITS). Additionally, he obtained his professional engineering certification (Ir.) in 2018. As a full-time faculty member at the University of Mataram, he actively contributes to academia while also serving as a consultant in Mechanical, Electrical, and Plumbing (MEP) systems and computing. His dedication to research is reflected in his extensive publications, including reference books and scholarly articles in national and international journals. He has been an active member of IET since 2014 and IEEE since 2018, continuously engaging in professional and research communities

. **Ida Ayu Sri Adnyani**. has been a faculty member at the Department of Electrical Engineering, Faculty of Engineering, University of Mataram since 1998. She earned her Bachelor's degree (S.T.) in Electrical Engineering from Udayana University in 1997. She completed her Master's degree in Ergonomics and Work Physiology in 2003 and her Doctoral degree in the same field in 2013, both at Udayana University. Currently, she serves as a lecturer at the Department of Electrical Engineering, University of Mataram. Her research interests focus on Electric Power Systems.

P erdana Putra I Ketut is a lecture at Electrical Engineering Departement, Faculty of Engineering, Mataram University since 2000. He complete her Bachelor's degres in 1997 and Master degree in 2004 at Electrical Engineering Departement of Gadjah Mada University Yogyakarta. . Currently, she serves as a lecturer at the Department of Electrical Engineering, University of Mataram. Her research interests focus on Renewable energy, Sustainable Energy and Ergoelectrical.

AUTHOR CONTRIBUTIONS

The research team consists of three authors, each assigned specific responsibilities to ensure effective task distribution and successful publication. **I Ketut Wiryajati** is responsible for designing the research framework, developing the control algorithms (PWM, MDCS, and PI Controller), and conducting simulations using MATLAB/Simulink. **I Ketut Perdana Putra** handles data acquisition, performance analysis (including voltage output, power loss, and efficiency calculations), and prepares visualizations such as waveform plots and comparative charts. **Ida Ayu Sri Adnyani** is in charge of compiling the literature review, translating technical results into a structured scientific paper, and managing the final editing and submission process to a reputable journal. This clear division of tasks ensures that each aspect of the research—modeling, analysis, and publication is addressed with focus and expertise. Through this collaborative effort, the team aims to produce a high-quality publication that contributes significantly to advancements in Boost Converter control techniques