Journal of Science Engineering Technology and Management Science
Volume 02, Issue 03, March 2025 *ISSN: 3049-0952*
www.jsetms.com *DOI: https://doi.org/10.5281/zenodo.14969959*

Evaluation of a Single-Phase Resonant Inverter's Quality

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To Cite this Article
Raja Sekhar Reddy, "Evaluation of a Single-Phase Resonant Inverter's Quality", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 03, March 2025, pp:01-05

Abstract: *A simulation technique examined the quality output of a single phase PWM (pulse width modulated) voltage source inverter incorporated with series-parallel resonant inverter configuration. The output voltage and current harmonic contents helped evaluate the inverter performance both with and without filter implementation. Researchers have designed and tested two variations of single phase PWM inverter with an evaluated LLCC (series-parallel) filter. The inverter requires an RMS value controller as its subsequent element to secure steady output signals. The proposed work yields beneficial effects on inverters that need minimum THD percentages alongside high-quality AC output.*
Keywords: *Series parallel filter, THD, PWM inverter, and resonant inverter*

I. Introduction

High-quality AC power becomes mandatory for various applications such as motor drives alongside emergency power supplies which also include uninterruptible power supplies (UPS) while hospitals and aerospace applications fall under the same category. The creation process frequently uses pulse width modulated PWM inverters as a solution. The production of high-quality less distorted sinusoidal output demands a PWM inverter to operate at elevated switching frequency. The higher operating frequency of PWM control in inverters creates two main problems which generate severe stress on semiconductor devices together with substantial power losses.

The issues are solved through Inverters that use resonant-filter principles. The duration of switching device turn-on and turn-off is constrained by soft-switching methods when switching device's current or voltage reaches a nearly zero state. The resonating of the load through the inverter results in substantial reductions of stress level combined with power losses and EMI losses and filter size.

The performance of inverters receives an increase from implementing resonant filter techniques which prolongs the operating life of switching components. When an inverter operates with hard switching techniques it produces greater harmonic disturbance on its output. The performance enhancement of inverters depends on total harmonic distortion (THD) measurements in both output voltage and current signals particularly since higher order harmonics with minimal magnitude influence inverter performance. The resonant filter provides simple access to eliminate higher order harmonics.

II. Research Method

A low pass filter becomes essential in the complete bridge output to generate the undistorted output sinusoidal voltage illustrated in Figure 1. A second-order LLCC low pass filter can eliminate all high-frequency harmonics that exist in the PWM sine waveform. A cutoff frequency selection was made for the low pass filter to produce output total harmonic distortion (THD) below 7%. The presence of resistance within the inductor along with the capacitor of the resonant filter decreases both the inverter's output voltage and current.

The feedback path contains an RMS controller that maintains voltage magnitude according to Figure 2 and Figure 3. The PWM inverter operates with an RMS controller which behaves as a PI controller for feedback operations. The proportional control component decreases the steady state error magnitude. In the feedback control process the comparator received both the load voltage and the designated reference output value. The comparator generates an error signal after operation. The signal error was analyzed in reference to standard modulation index. A PWM pulse generator obtained the signal output which generated switching pulses through multiplexed formation (Figure 4).

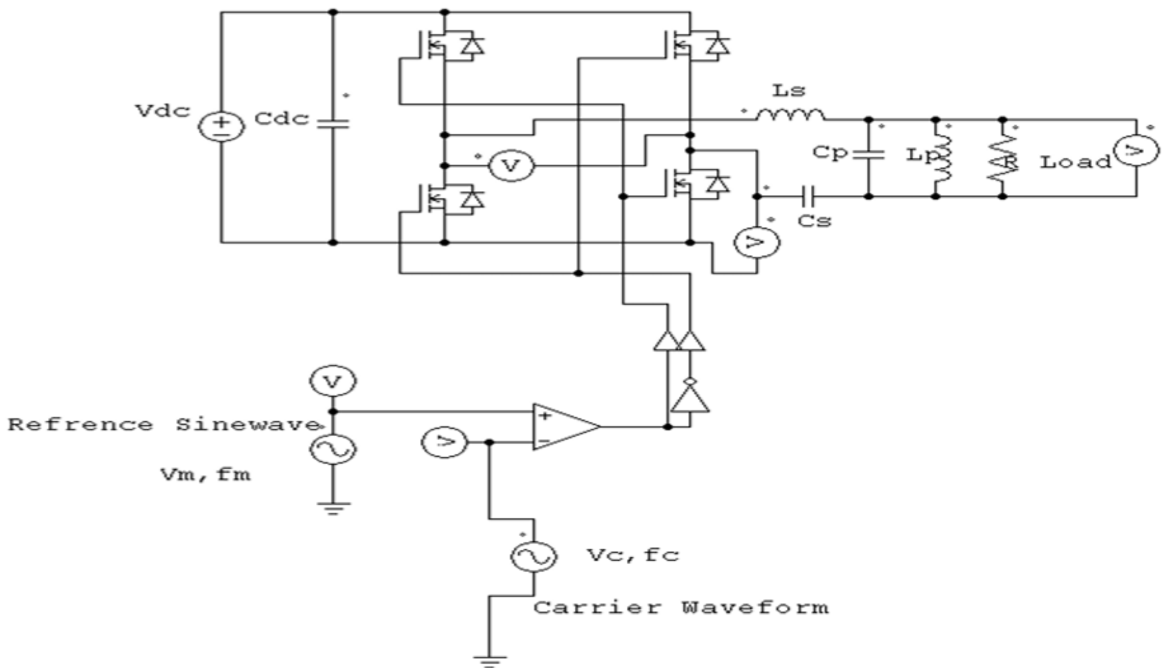

Fig 1: PWM inverter designed circuit

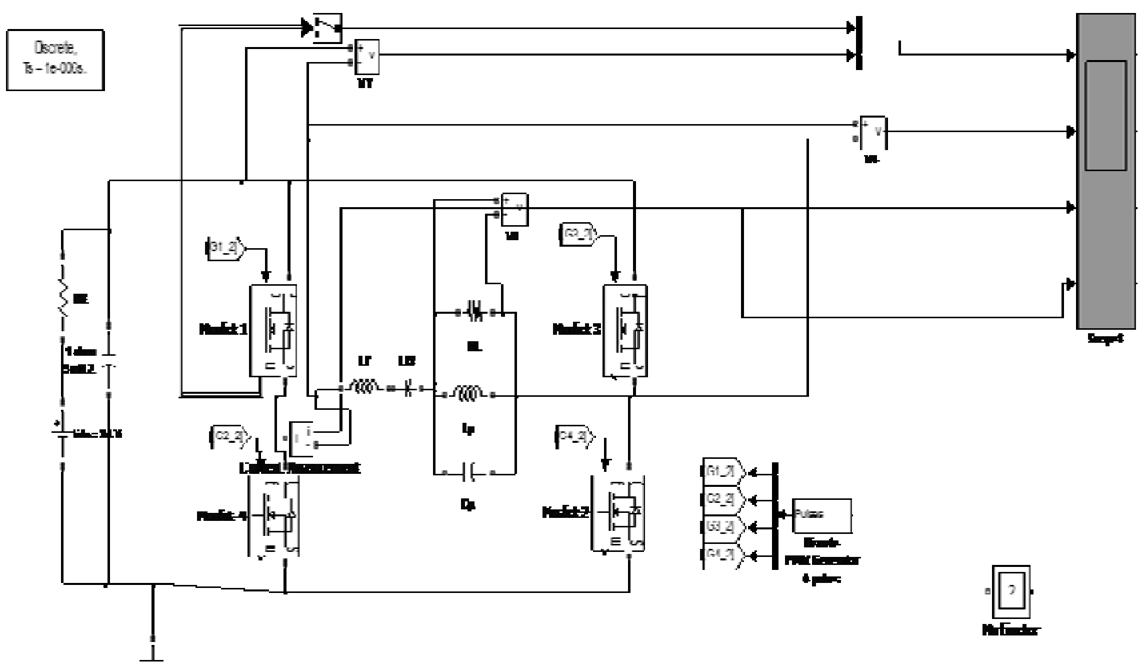

Fig 2: PWM inverter with series-parallel filter Simulink diagram

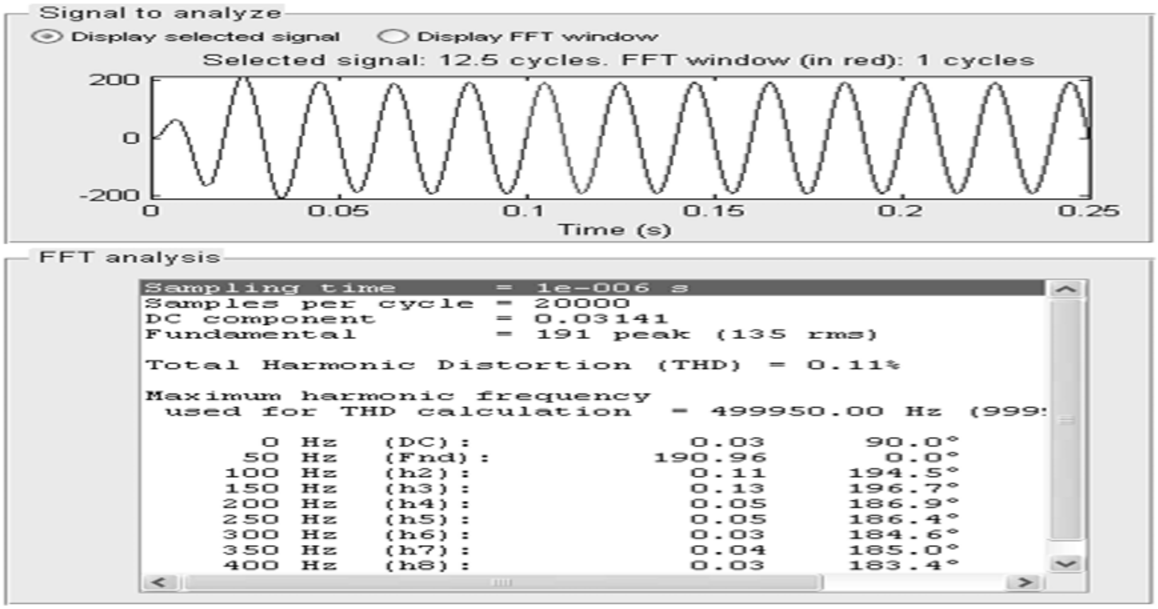

Fig 3: FFT window and harmonics contents inverter without series

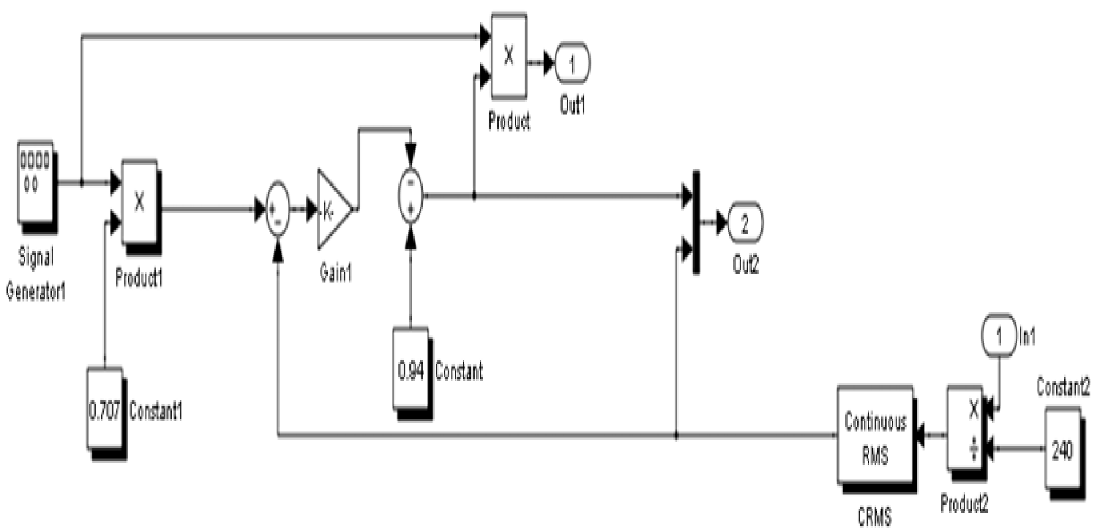

Fig 4: Feedback controller internal block diagram

III. Result and Analysis

The PWM inverter's output voltage and current were subjected to harmonic analysis. The voltage waveforms of a PWM inverter with and without an LLCC resonant inverter are displayed in Figure 5. With a resonant filter, the current was 0.82% and 4.12%, respectively. It shows that when an LLCC parallel resonant filter is used, the output voltage and current harmonic contents decrease to the point where a feedback controller is required to regulate the output voltage magnitude to match the rated value. The voltage of the controller nearly stays at its rated value when RMS feedback is used.

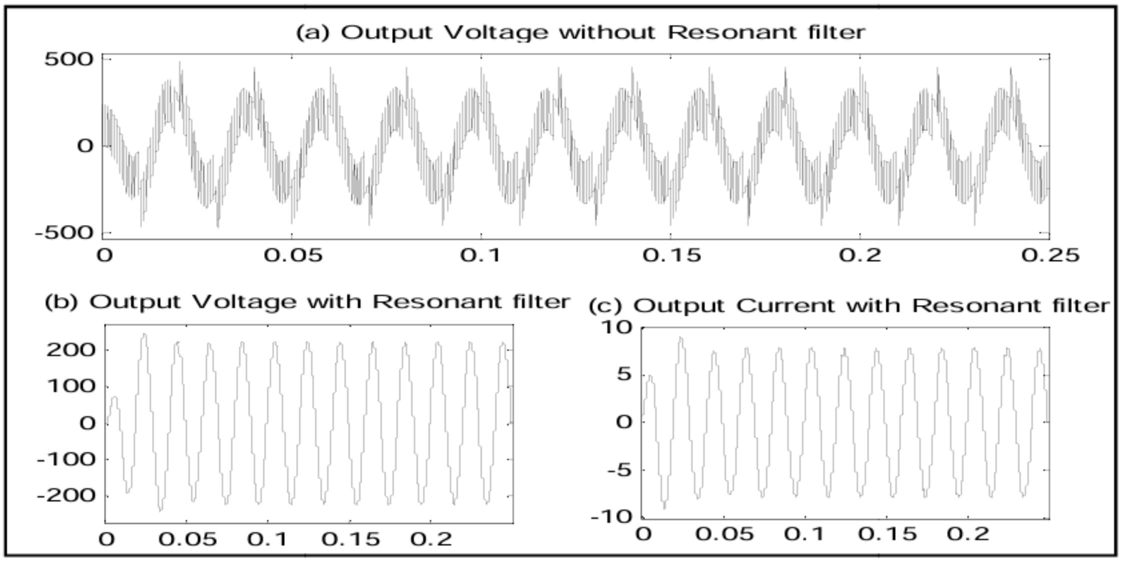

Fig 5: Output voltage without resonant filter (b) Output voltage with resonant filter (c) Output current with resonant filter

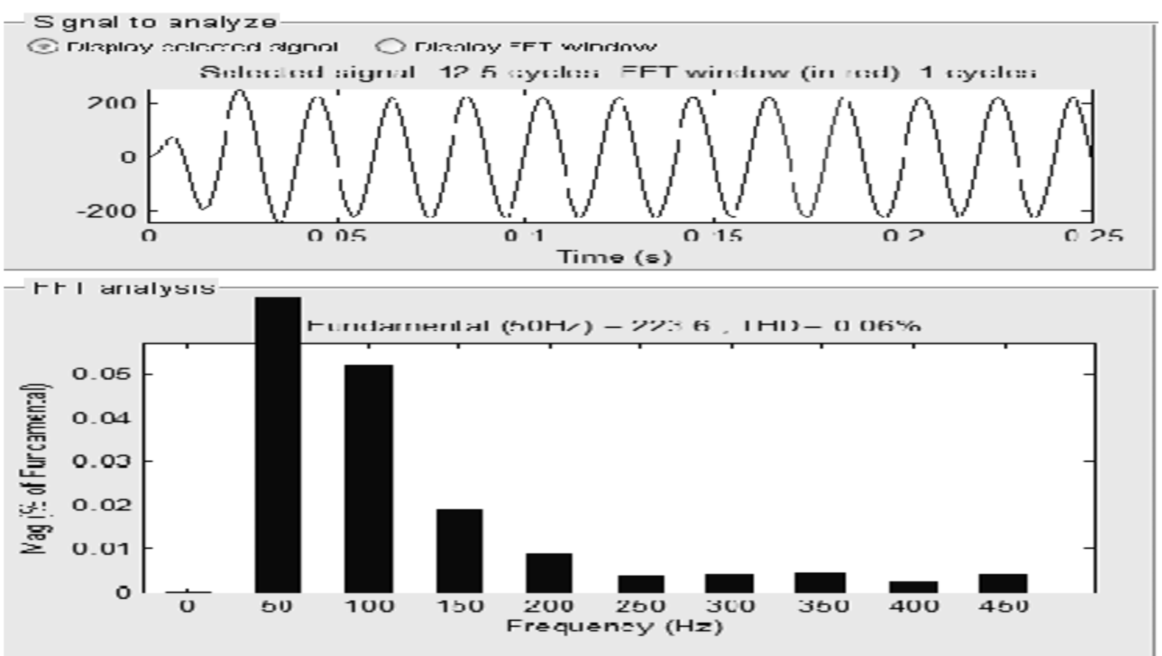

Fig 6: PWM inverter with series window and harmonics contents % THD - O/P voltage analysis diagram of single phase PWM inverter with series –parallel resonant filter and PI controller

IV. Conclusion

A single phase PWM inverter with a series parallel filter has undergone harmonic analysis. For a range of load change values, the result obtained with and without a series resonant filter lowers the percentage (%) THD by more than 4%. The RMS controller proved helpful as a feedback controller. The output has been steady and consistent since the feedback controller was introduced. This method also lowers the inverter's switching losses.

References

[1] K. M. Smith, Jr. and K. M. Smedley, "A comparison of voltage converters," IEEE Trans. Power Electronics

[2] Dudek, J. and P. Chlebis, "Comparison o inverters", Proceedings of 35th Annual Aachen, Germany, 2004. M. Smedley, "A comparison of voltage-mode soft switching methods for PWM IEEE Trans. Power Electronics, vol 12, no. 2, pp. 376–386, Mar. 1997. switching methods for PWM Dudek, J. and P. Chlebis, "Comparison of power losses and quality of output voltage from different types of inverters", Proceedings of 35th Annual IEEE Power Electronics Specialists Conference, PESC f power losses and quality of output voltage from different types of IEEE Power Electronics Specialists Conference, PESC, pp. 3120-3126,

[3] J. L. Russi, J. R. Pinheiro, H. L. Hey, and M. L. da Silv techniques: A generic approach" J. L. Russi, J. R. Pinheiro, H. L. Hey, and M. L. da Silva Martins, "Coupled filter inductor soft techniques: A generic approach", in Proc. IEEE ISIE, pp. 919–924, Jun. 2007.

[4] A Martins, "Coupled filter inductor soft-switching S. Behera, S. P. Das, and S. R. Doradla, "Quasi-resonant soft-switching inverter for low and high power factor Electronics. Power Appl., vol. 151, no. 4, pp. 451–459, Jul. 2004.

[5] Low and high power factor Guoqiao Shen, Dehong Xu, Luping Cao, Xuancai Zhu, An improved control strategy for grid source inverters with an LCL filter, IEEE Transactions on Power Electronics, vol. 23,no.4,pp.1899 Guoqiao Shen, Dehong Xu, Luping Cao, Xuancai Zhu, An improved control strategy for grid-connected voltage 23,no.4,pp.1899-1906, Jul. 2008.

[6] "A Novel SVPWM Modulation Scheme", in Applied Power Electronics Conference and Exposition, 2009. APEC 2009. Twenty-Fourth Annual IEEE, 2009, pp. 128-131.

[7] S. Behera, S. P. Das, and S. R. Doradla, "Quasi loads", IEE Proc. Electronics. Power Appl [5] Guoqiao Shen, Dehong Xu, Luping Cao, Xuancai Zhu, An improved control strategy for grid source inverters with an LCL filter