Title: An accurate real time simulation tool for optimizing the design and performance of Power Electronics System

Company: Universal Real Time Power Conversion LLC

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Comparison of URTPC simulator with commercially available PSIM Simulator: In order to demonstrate high bandwidth and accuracy of URTPC simulator, the results of a simple 3-phase inverter when working as pwm rectifier with open loop is compared with a PSIM simulation results. The simulation is conducted for both cases with three fundamental frequencies 50Hz, 500Hz, 5kHz and 10kHz and 110V AC voltage and with a switching frequency of 200kHz. The simulation step size in both PSIM and URTPC simulator is 24ns. The Phase current and its harmonic spectrum are given for all three cases in Fig. 1 to Fig. 20 respectively. OPAL-RT reported 250ns step size for a 3-phase solar inverter [1,2]. For power converter with more switches the step size goes up in OPAL-RT simulator.

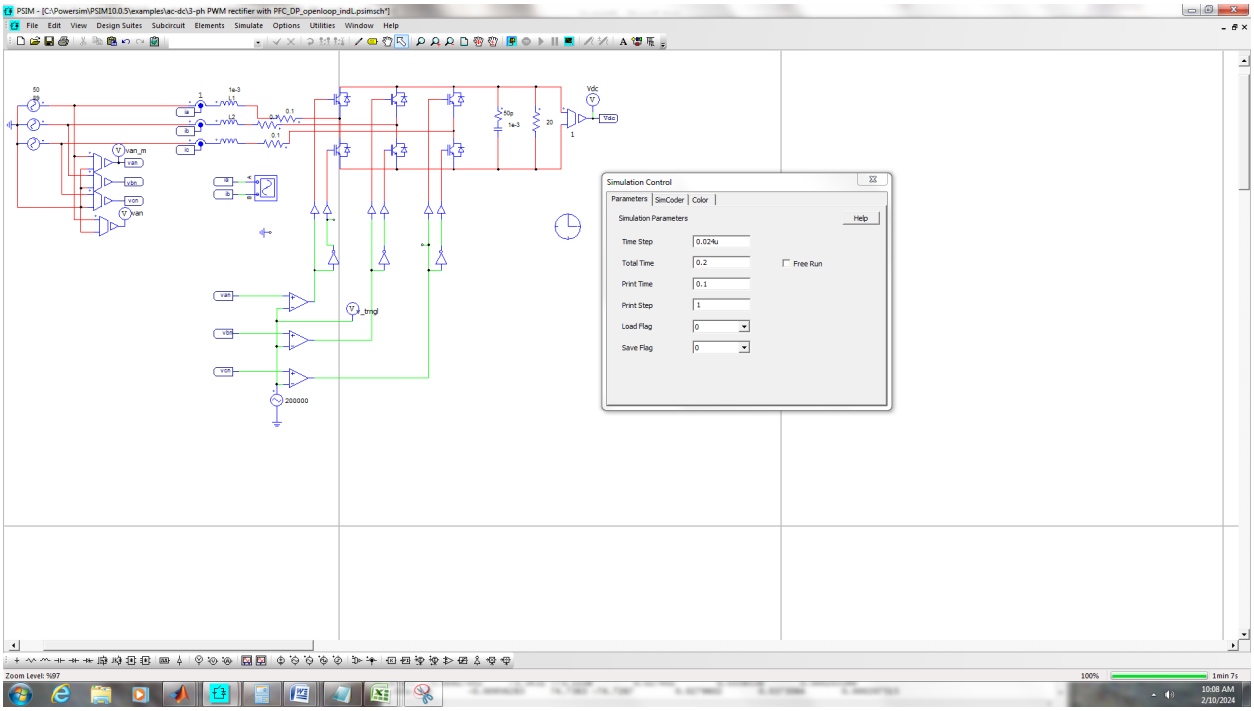
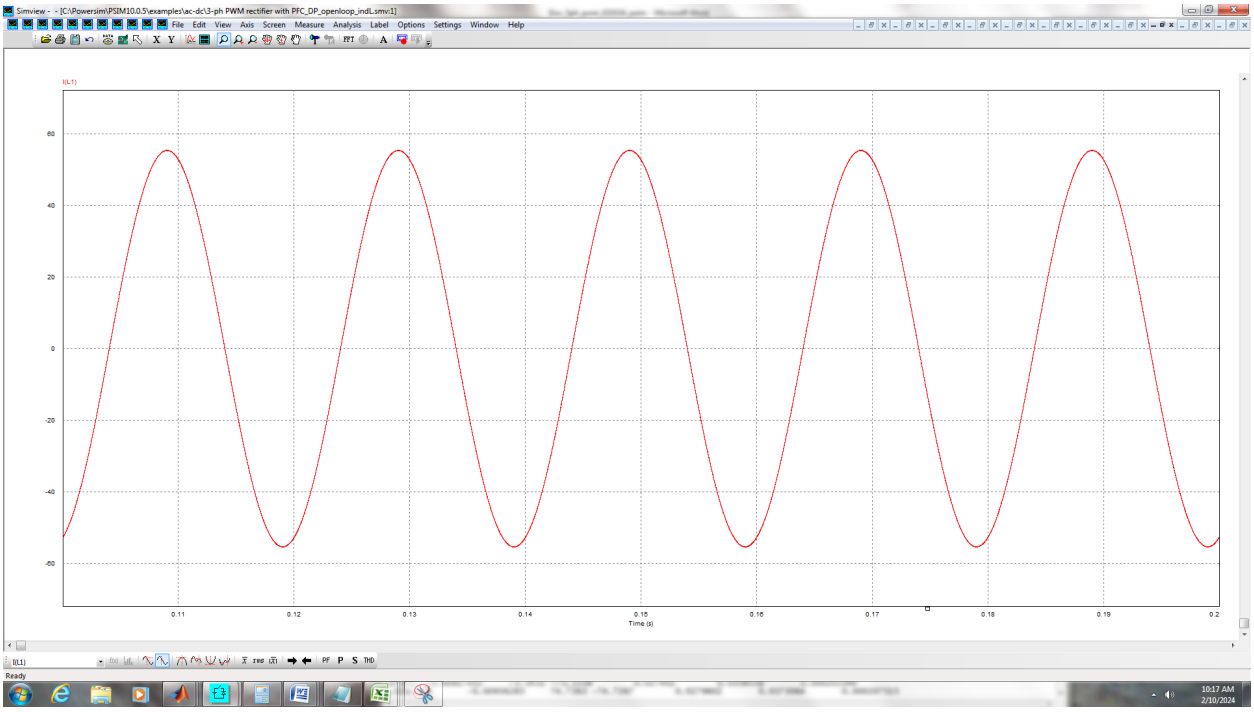
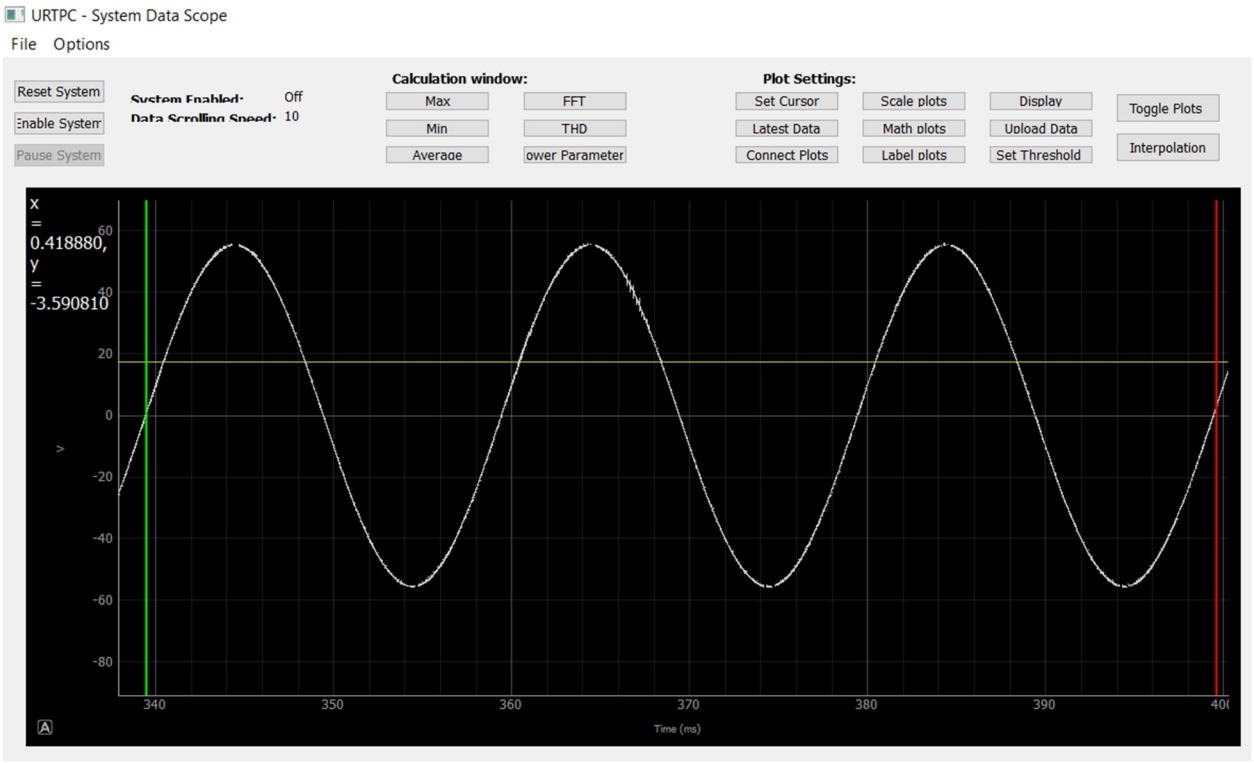


Fig. 1 The schematic of the 3-phase power converter as implemented in PSIM and URTPC simulator at 50Hz fundamental and 200kHz switching frequency with 24ns step size

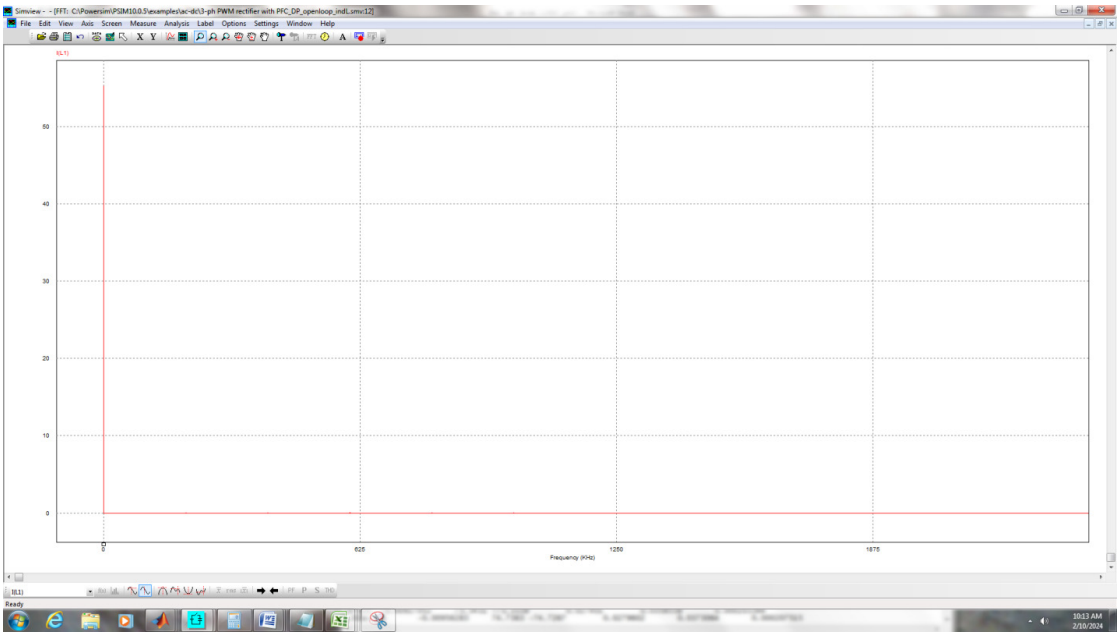


(A)

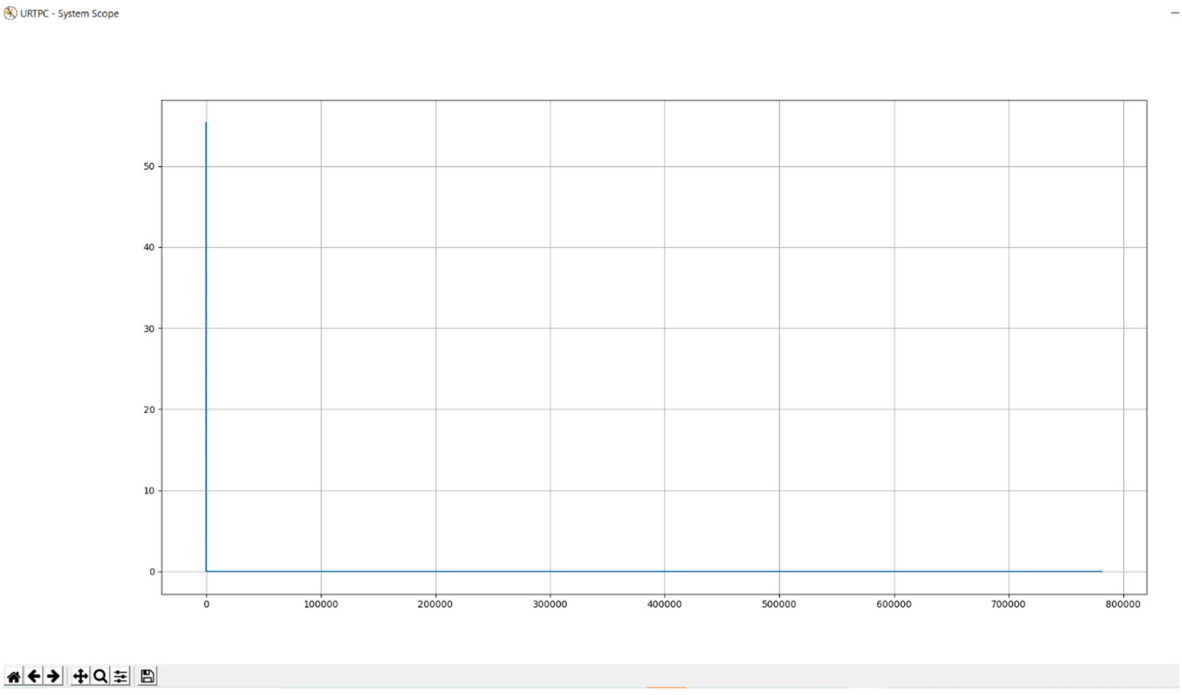


(B)

Fig. 2 Waveform of Phase current with PSIM (A) and URTPC (B) at 50Hz fundamental and 200kHz switching frequency with 24ns step size

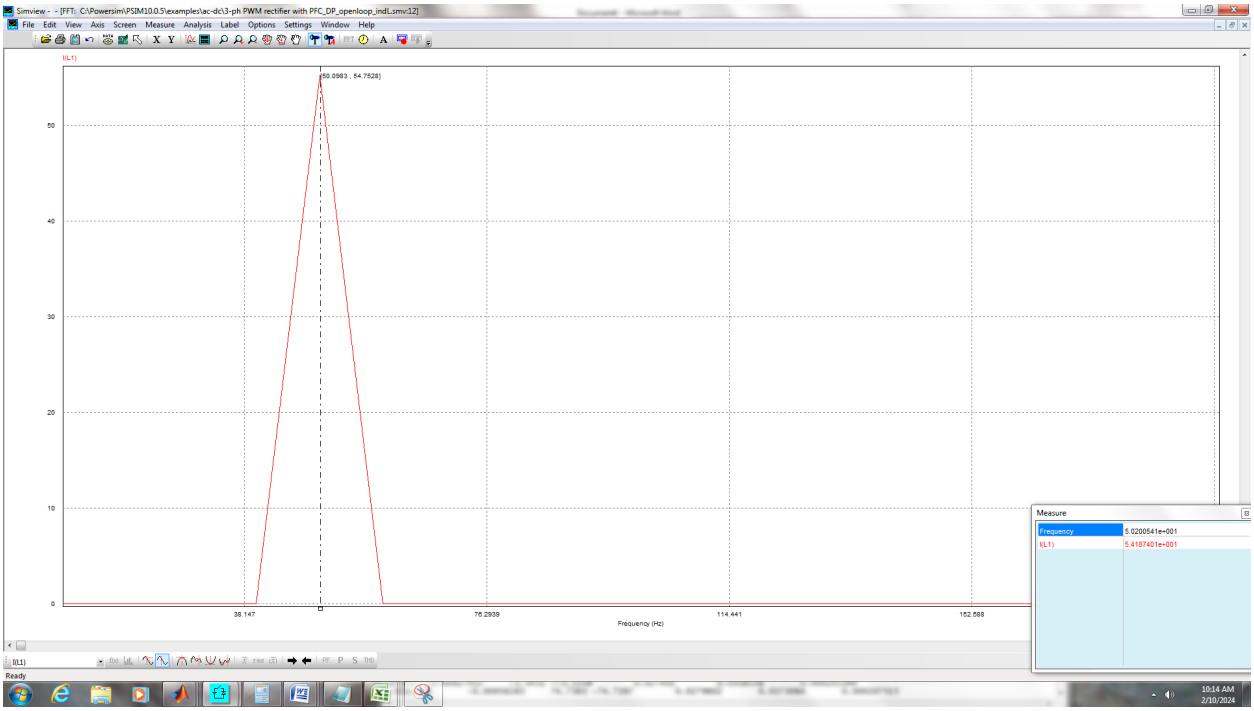


(A)

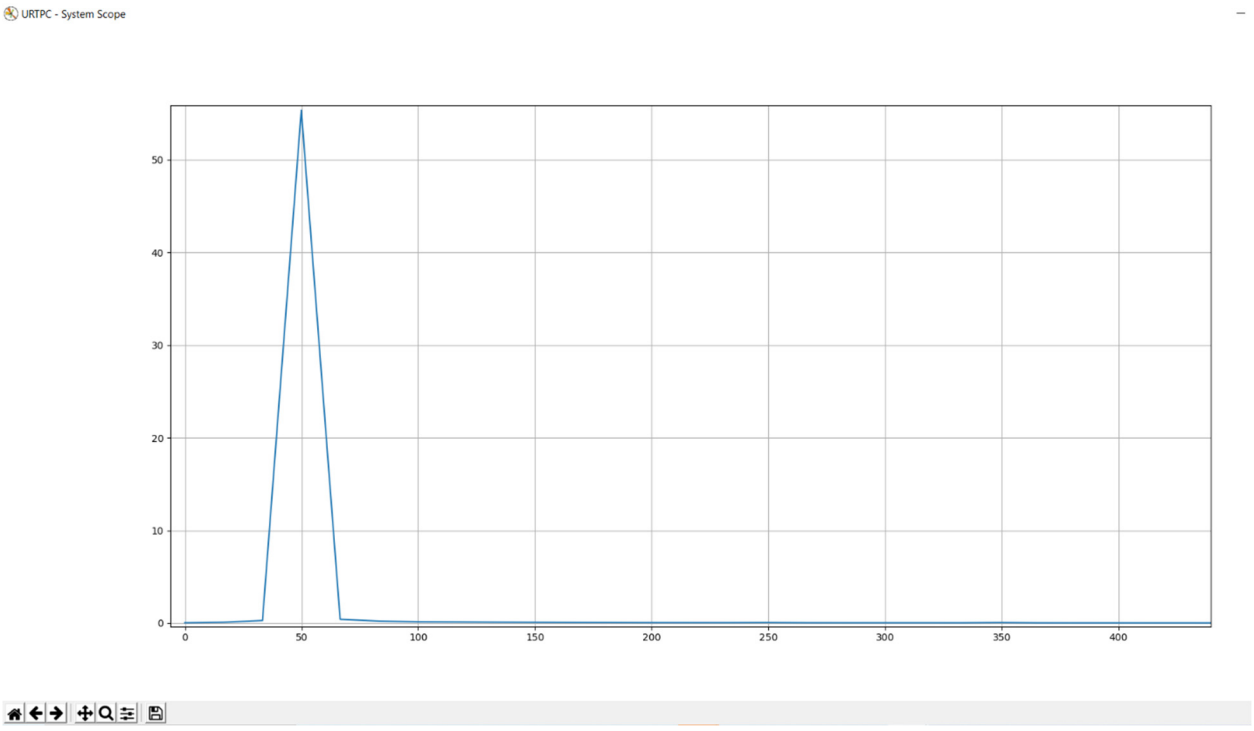


(B)

Fig. 3 FFT (full spectrum) of Phase current with PSIM (A) and URTPC (B) at 50Hz fundamental and 200kHz switching frequency

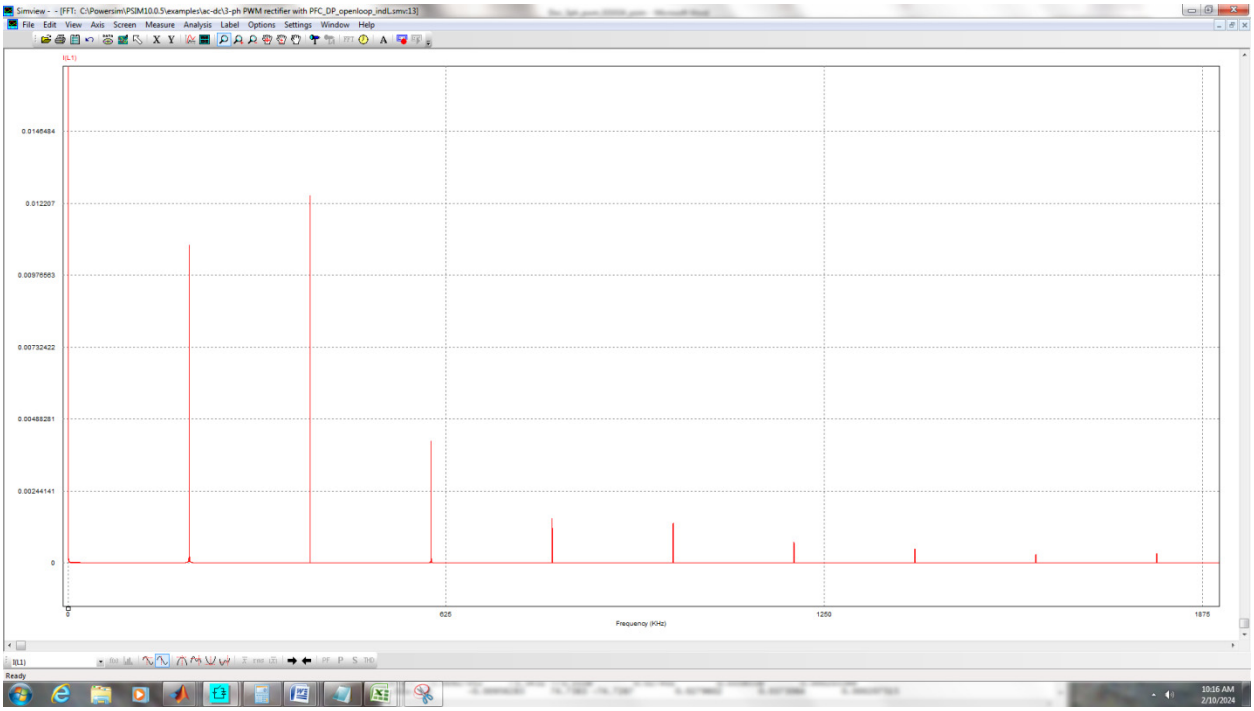


(A)

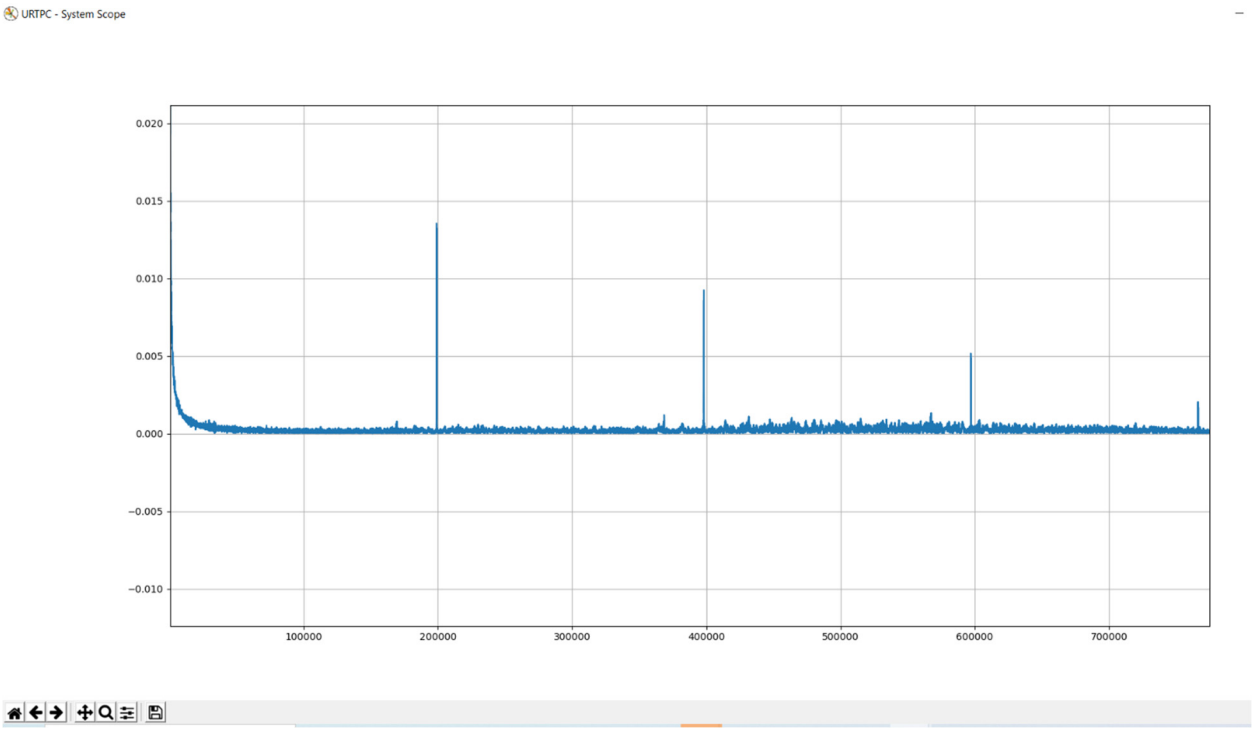


(B)

Fig. 4. FFT of the fundamental of Phase Current with PSIM (A) and URTPC (B) at 50Hz fundamental and 200kHz switching frequency



(A)



(B)

Fig. 5 FFT of the harmonics in Phase current with PSIM (A) and URTPC (B) at 50Hz fundamental, 200kHz switching frequency and 24ns step size.

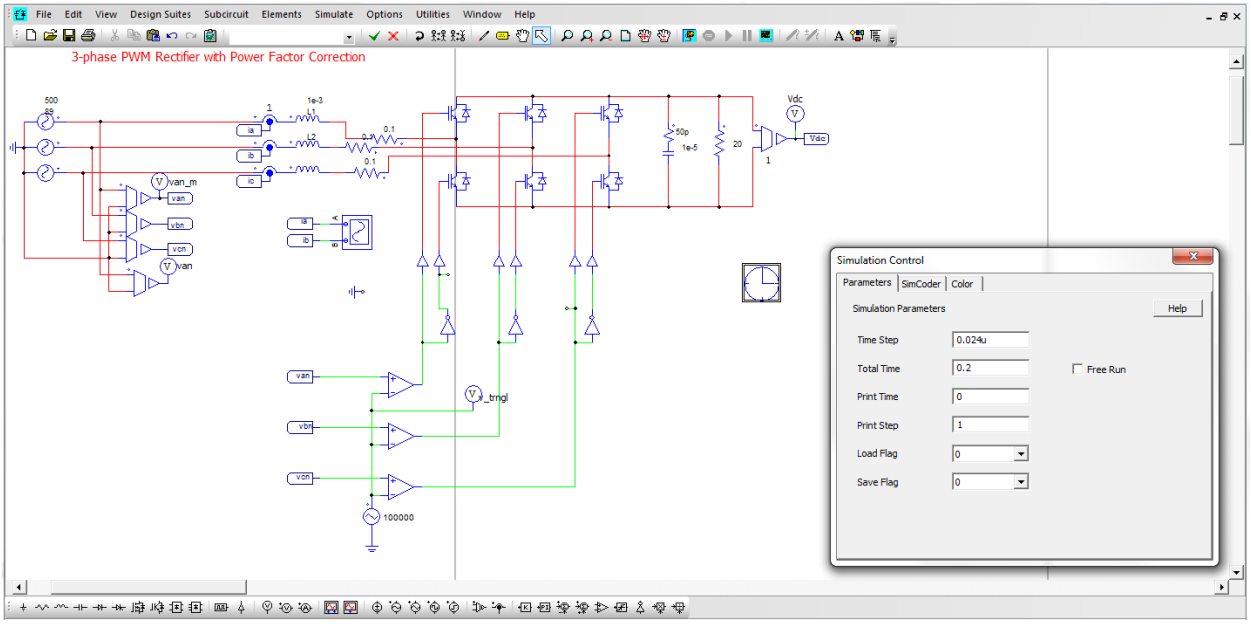
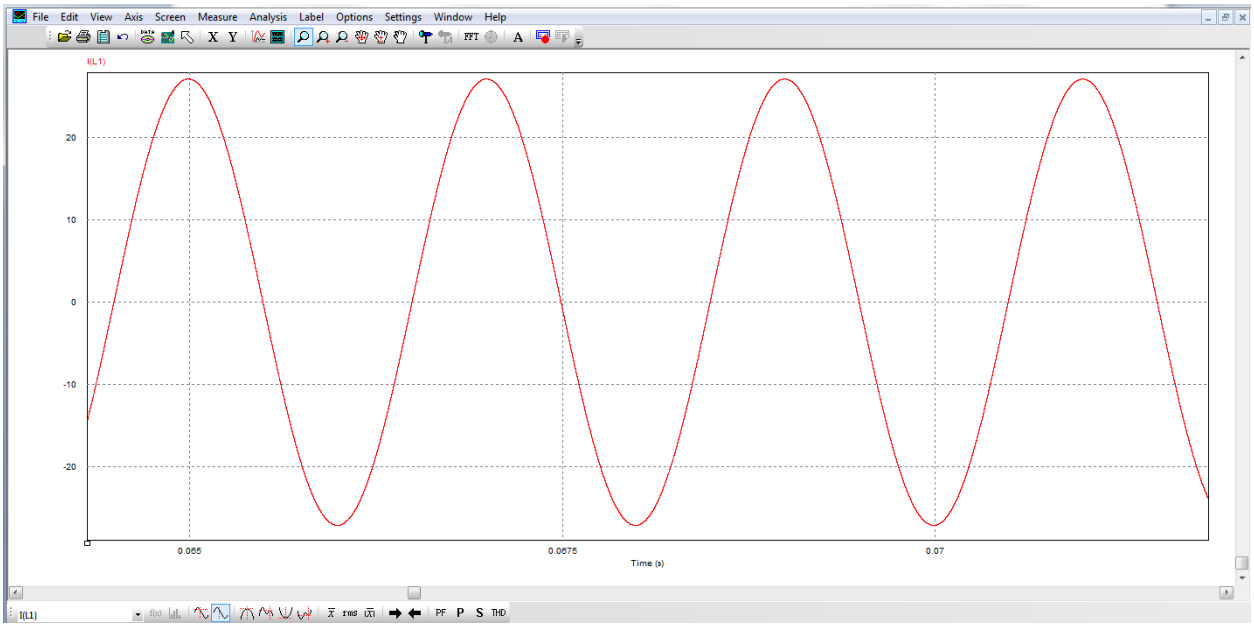
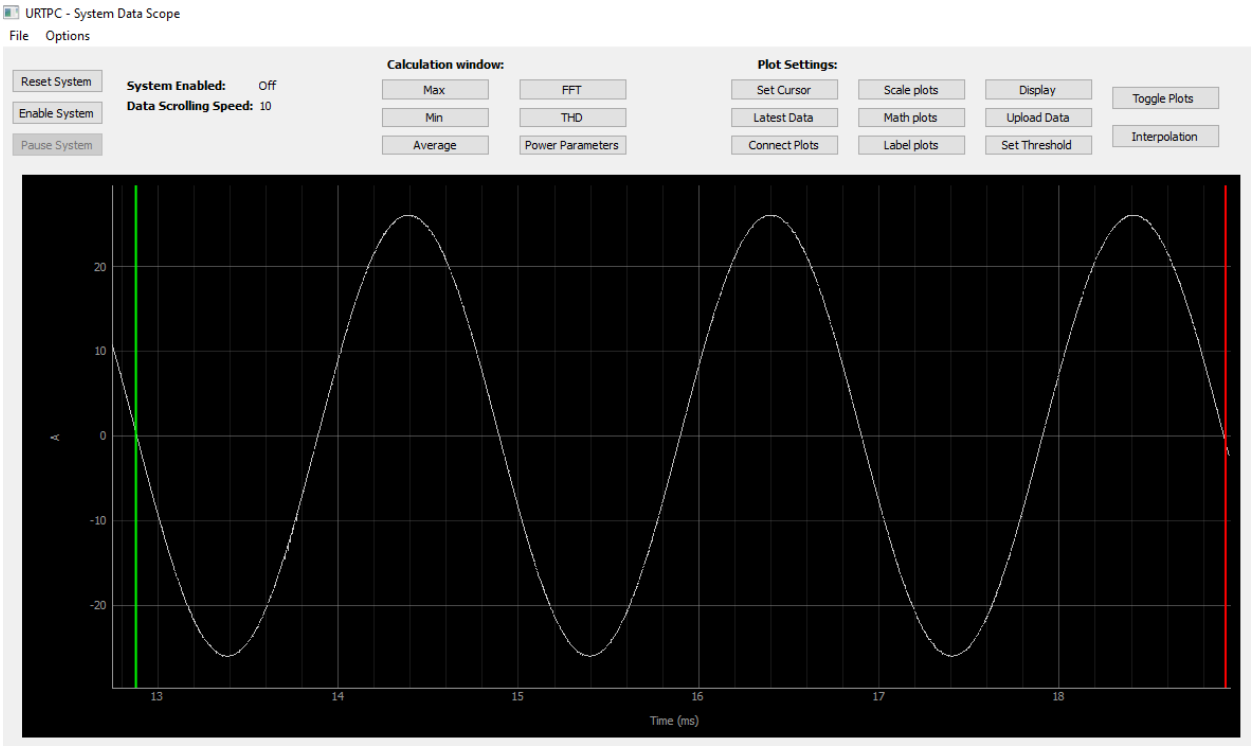


Fig. 6 The schematic of the 3-phase power converter as implemented in PSIM and URTPC simulator at 500Hz fundamental and 200kHz switching frequency with 24ns step size

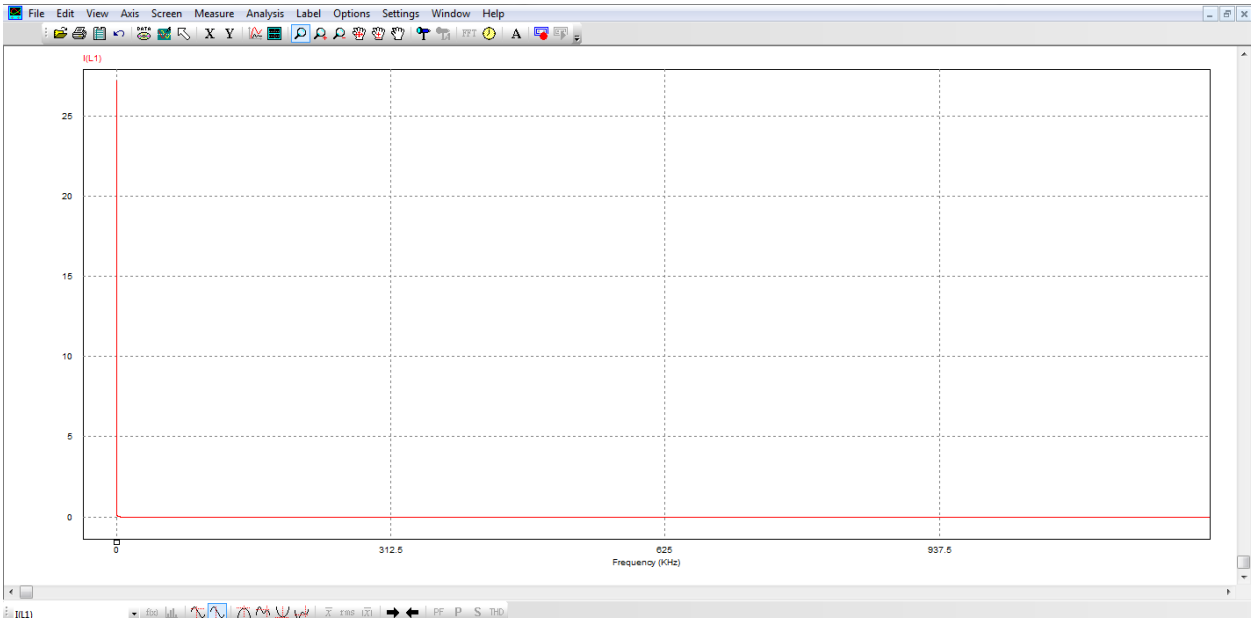


(A)

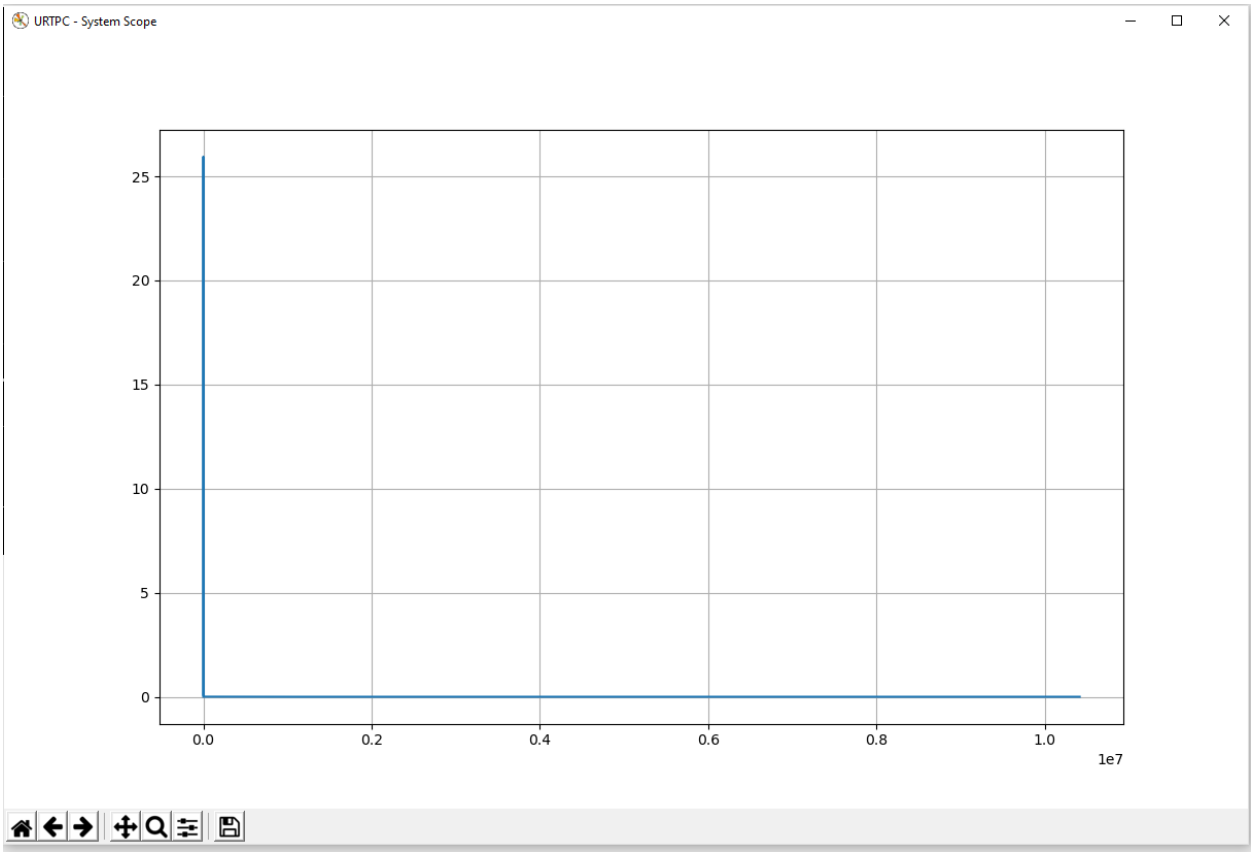


(B)

Fig. 7 Waveform of Phase current with PSIM (A) and URTPC (B) at 500Hz fundamental and 200kHz switching frequency with 24ns step size

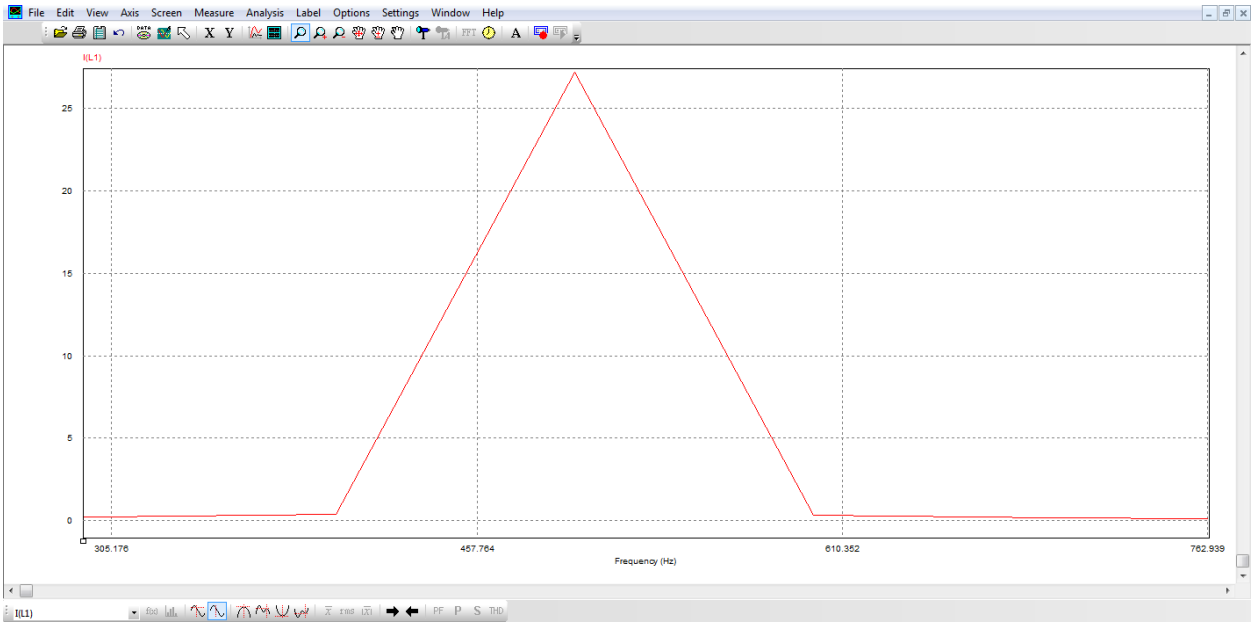


(A)

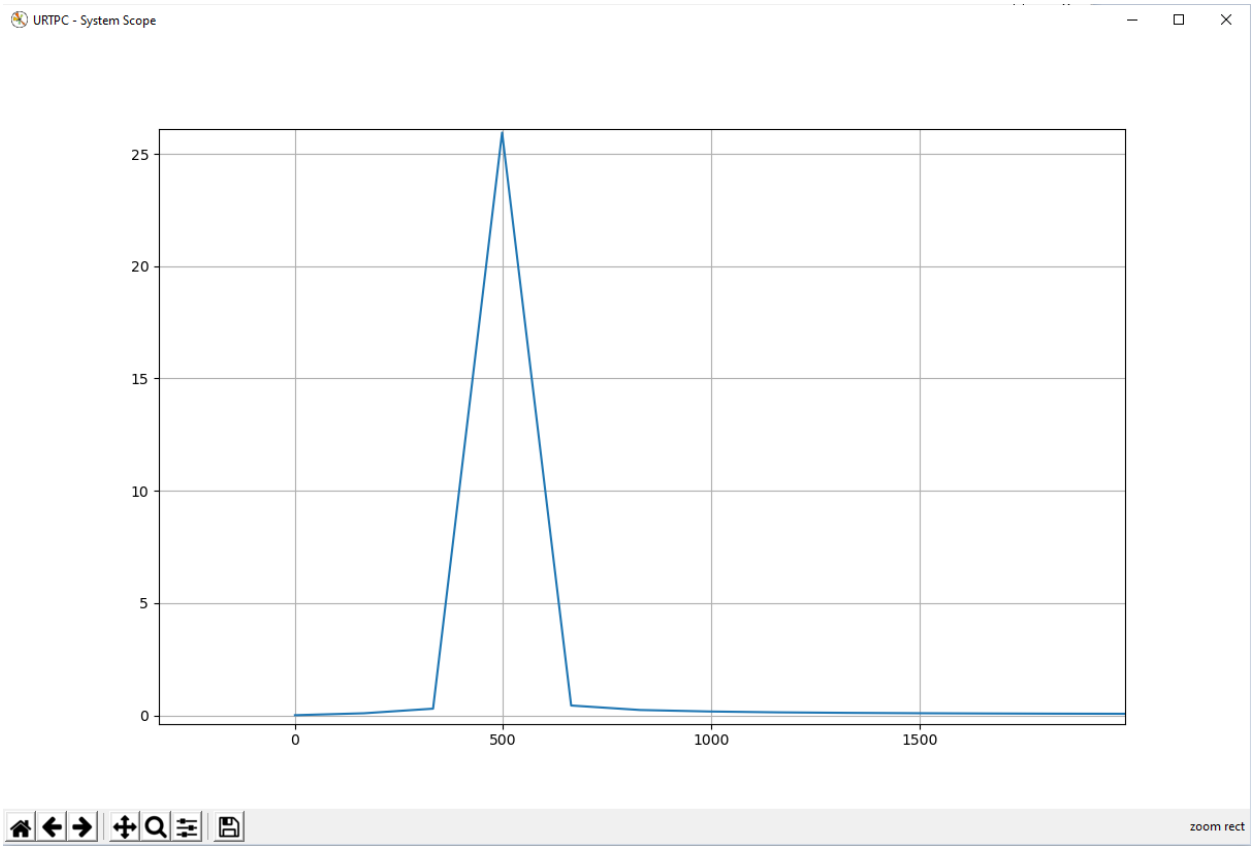


(B)

Fig. 8. FFT (full spectrum) of Phase Current with PSIM (A) and URTPC (B) at 500Hz fundamental and 200kHz switching frequency

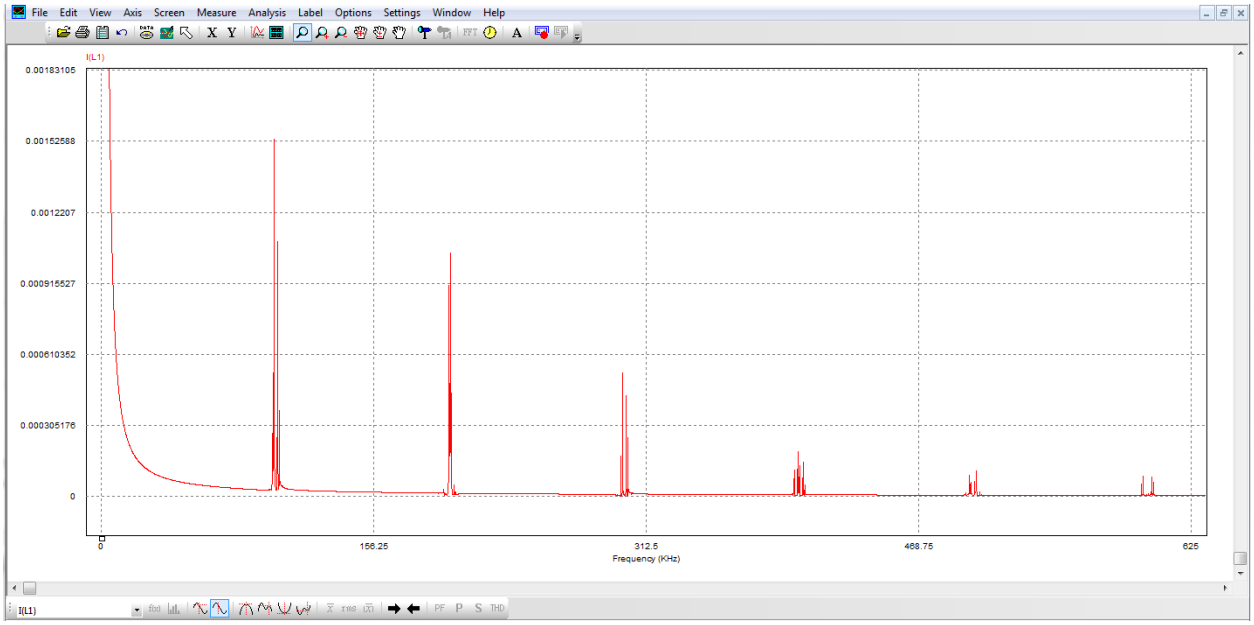


(A)

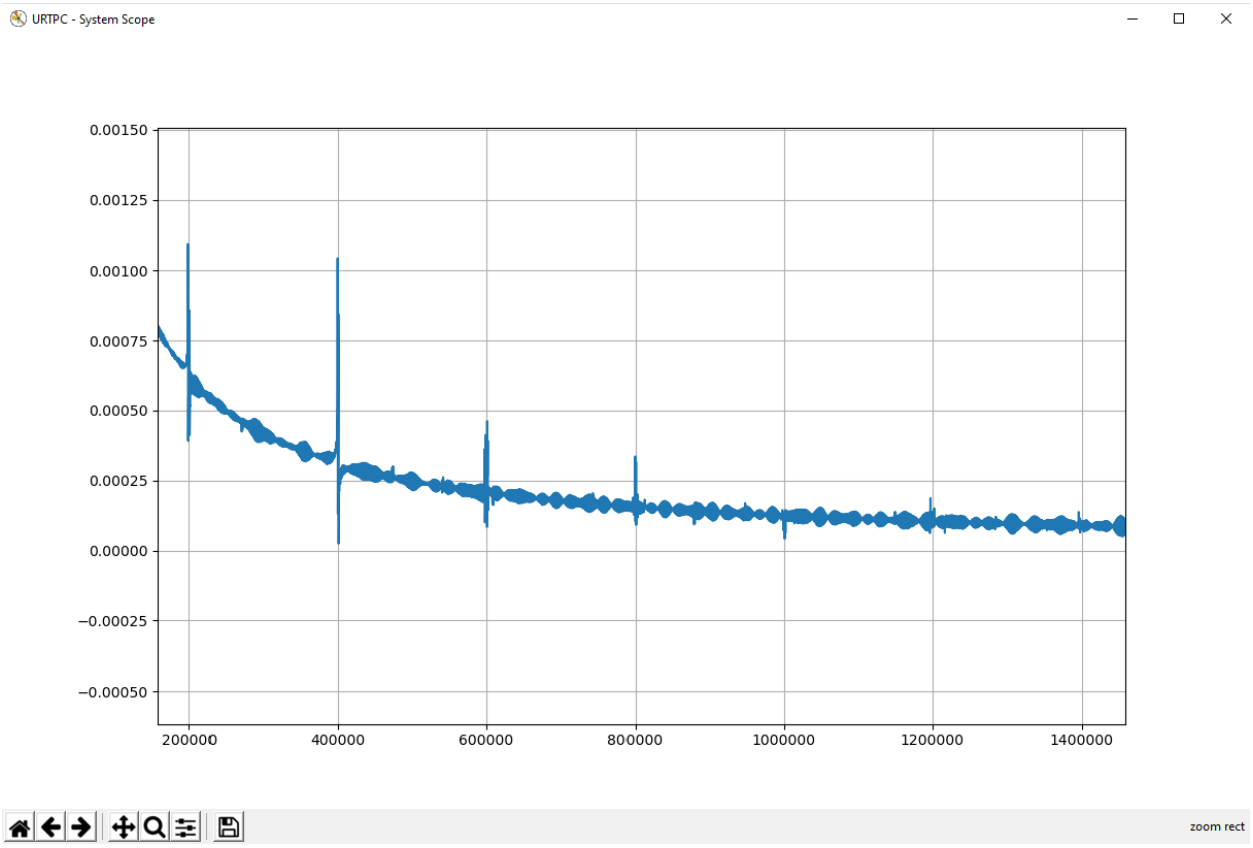


(B)

Fig. 9. FFT (fundamental) of Phase Current with PSIM (A) and URTPC (B) at 500Hz fundamental and 200kHz switching frequency



(A)



(B)

Fig. 10. FFT (harmonics) of Phase Current with PSIM (A) and URTPC (B) at 500Hz fundamental and 200kHz switching frequency

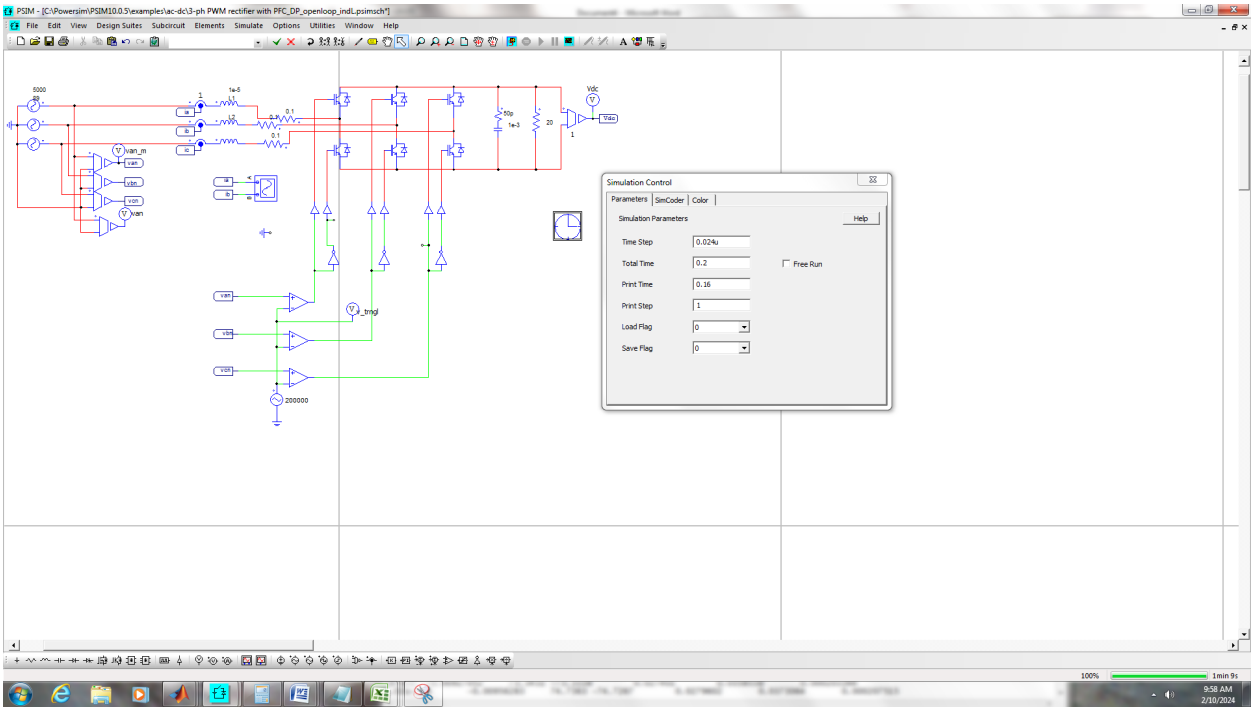
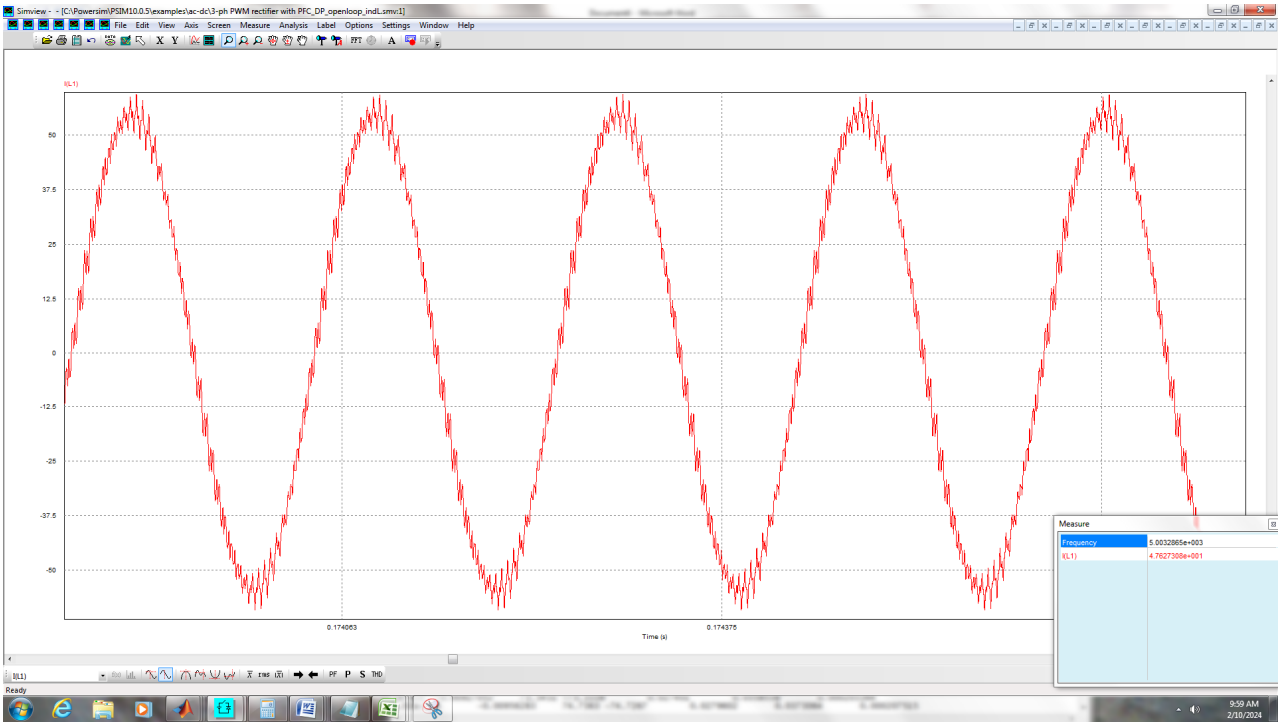
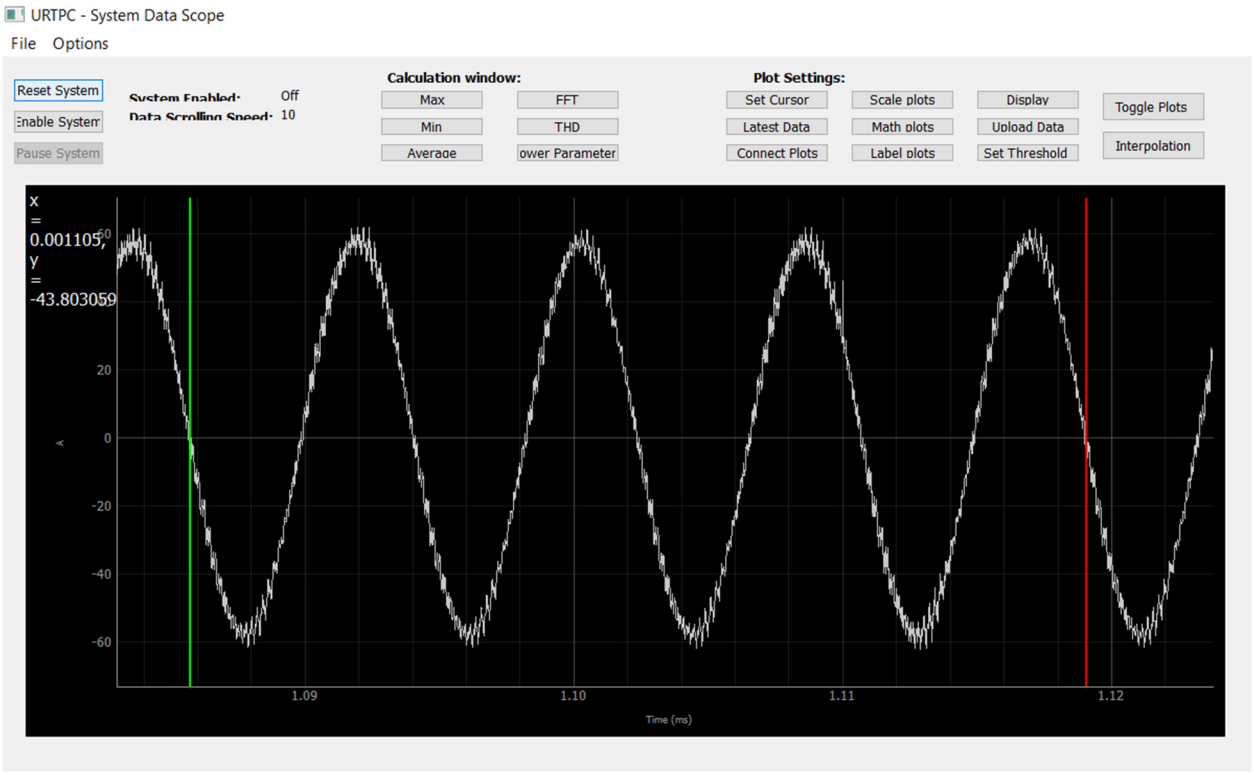


Fig. 11 The schematic of the 3-phase power converter as implemented in PSIM and URTPC simulator at 50Hz fundamental and 200kHz switching frequency with 24ns step size

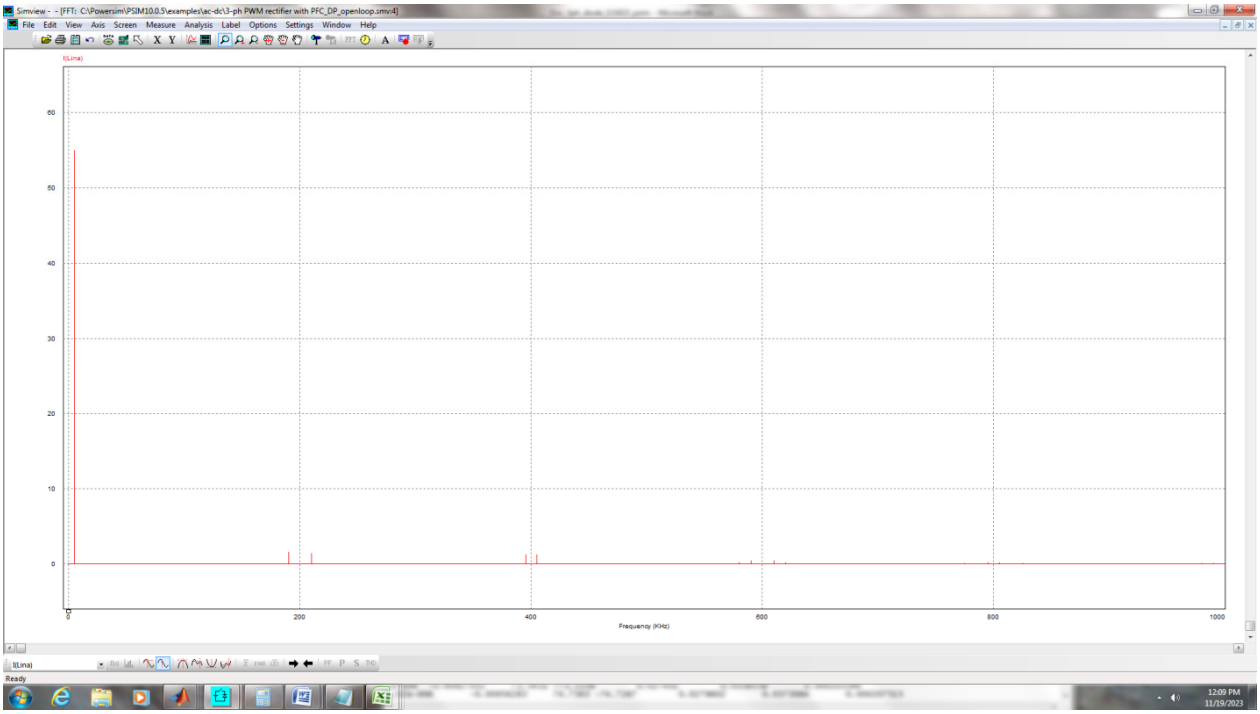


(A)

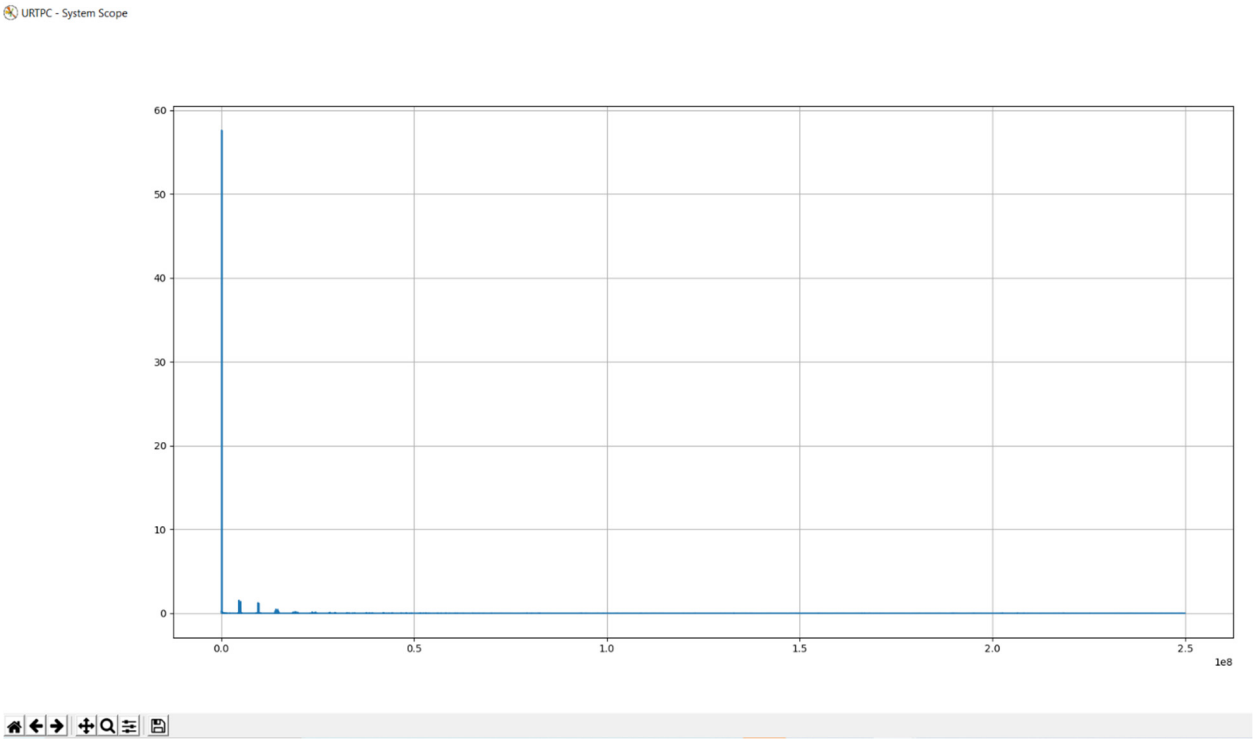


(B)

Fig. 12 Waveform of Phase current with PSIM (A) and URTPC (B) at 5kHz fundamental and 200kHz switching frequency with 24ns step size

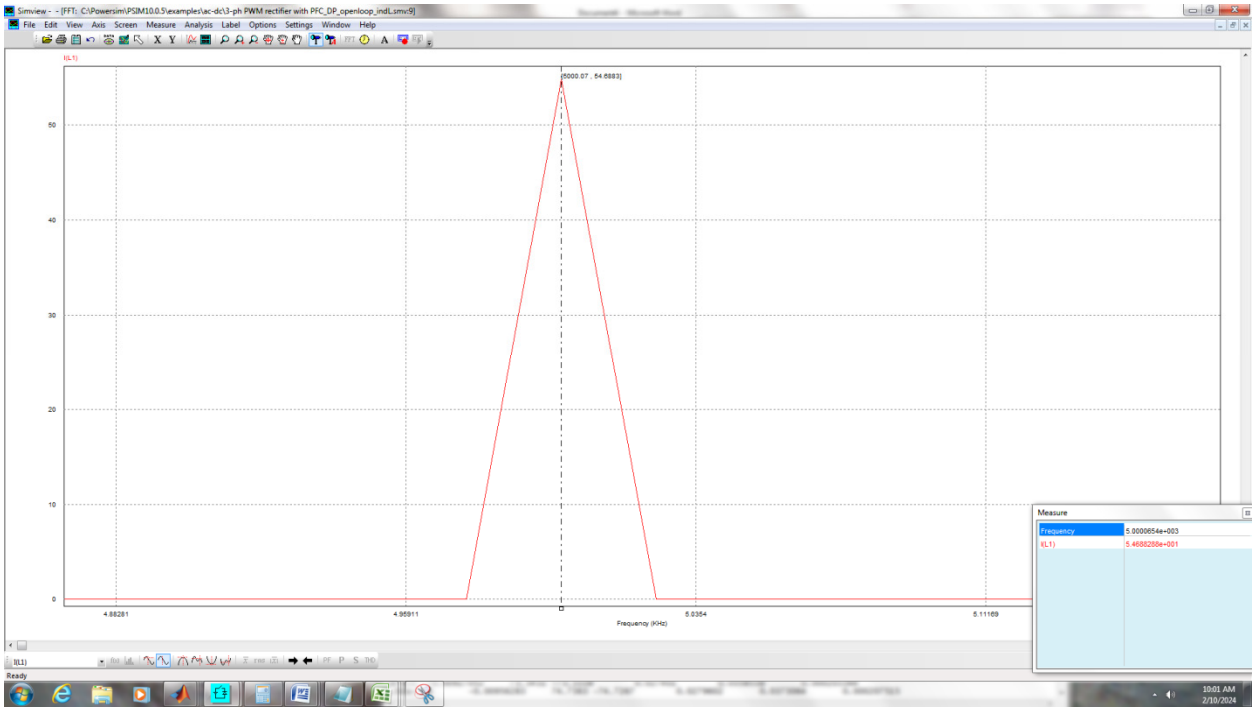


(A)

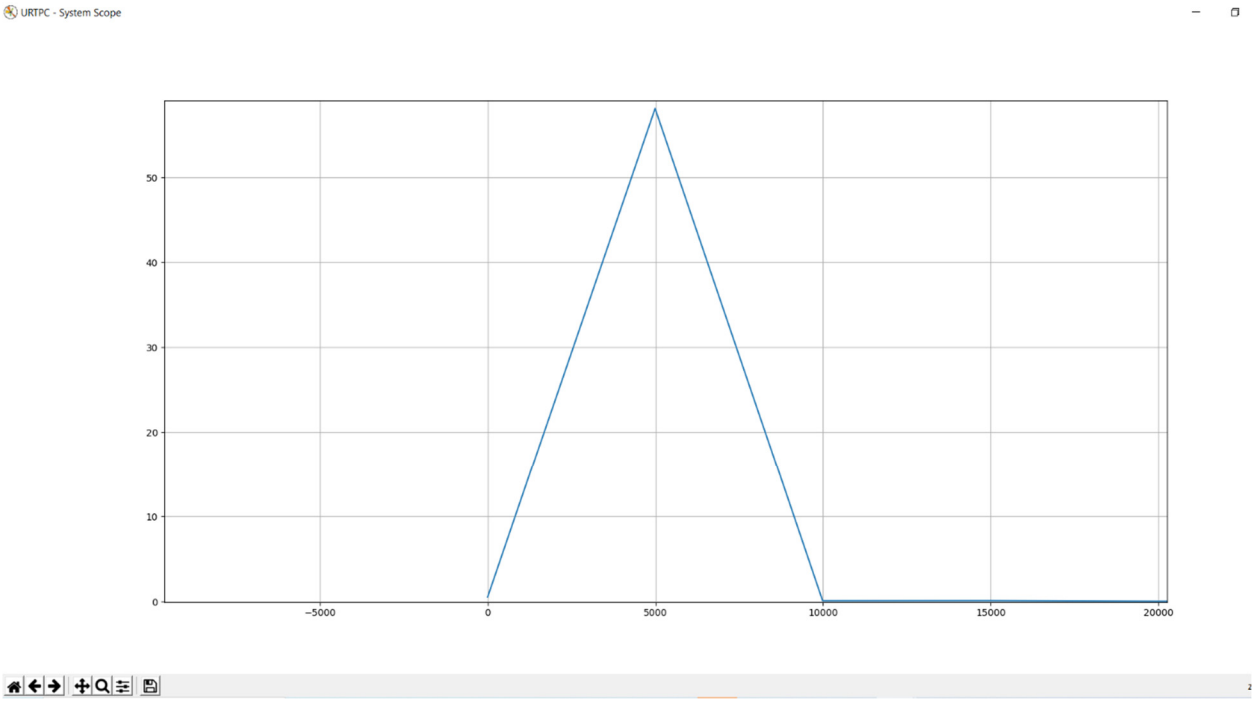


(B)

Fig. 13 FFT of full spectrum of Phase current with PSIM (A) and URTPC (B) at 5kHz fundamental and 200kHz switching frequency with 24ns step size

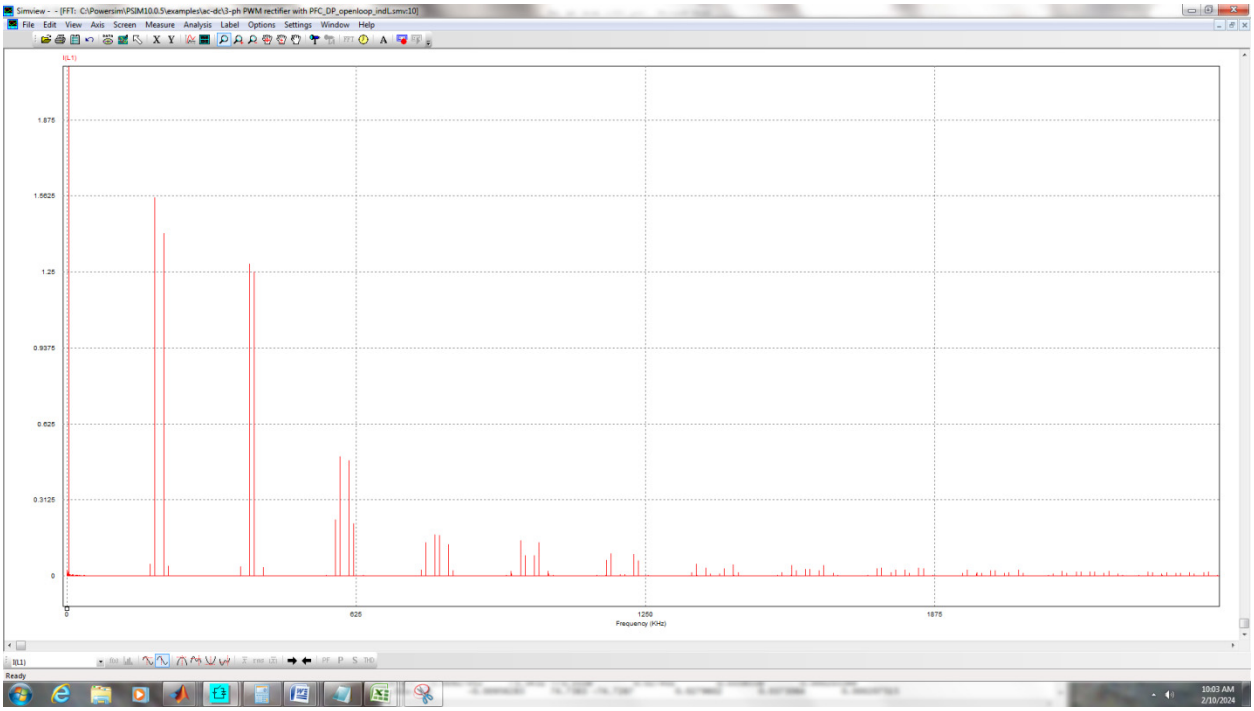


(A)

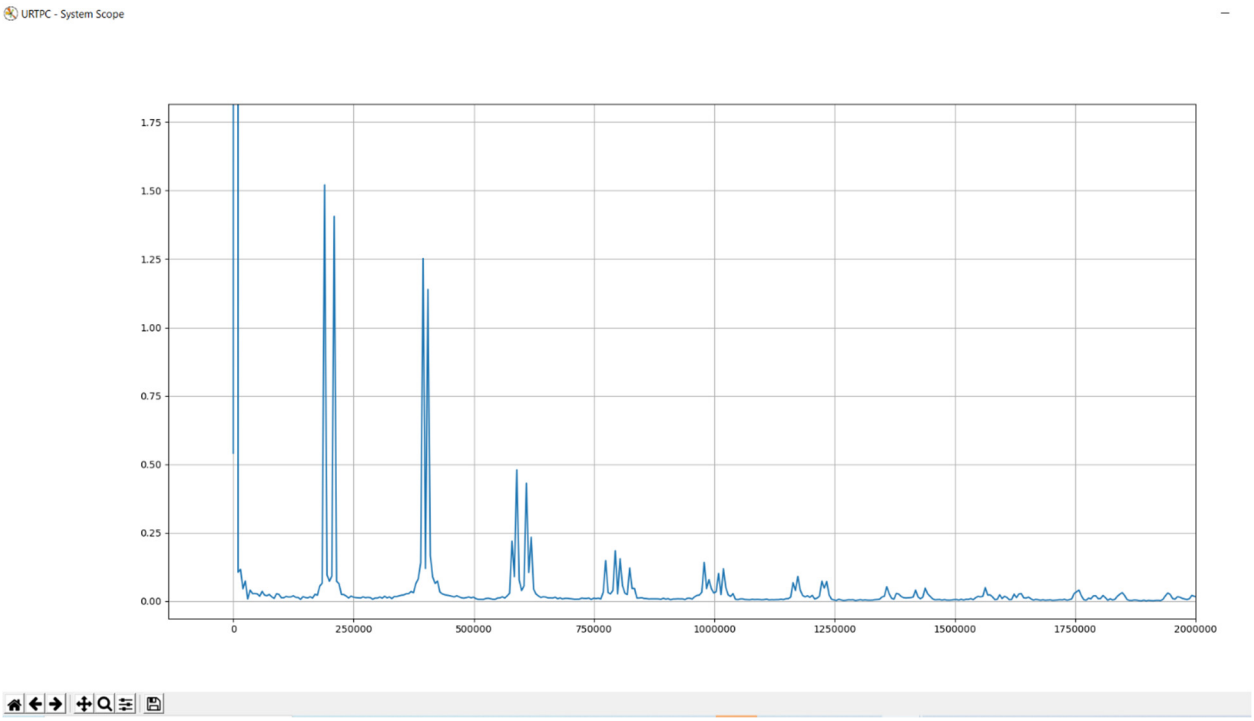


(B)

Fig. 14. FFT of the fundamental of Phase Current with PSIM (A) and URTPC (B) at 5kHz fundamental, and 200kHz switching frequency with 24ns step size.



(A)



(B)

Fig. 15 FFT of the harmonics in Phase current with PSIM (A) and URTPC (B) at 5kHz fundamental ad 200kHz switching frequency with 24ns step size.

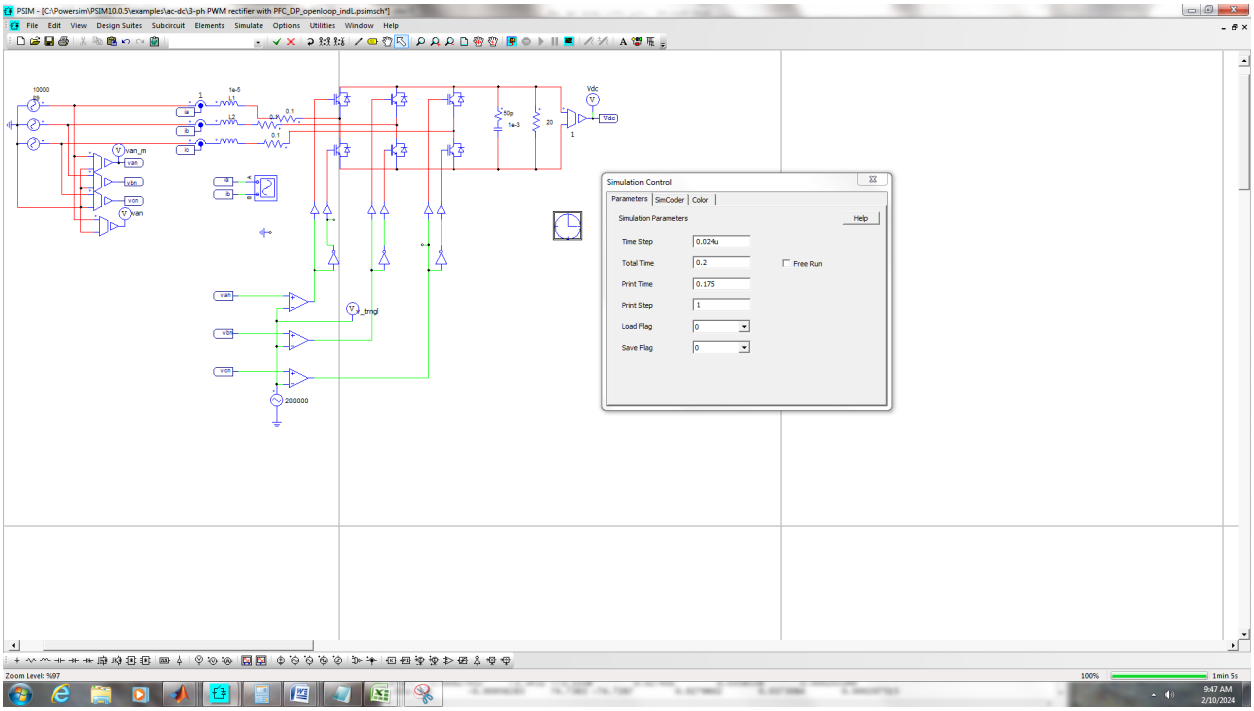
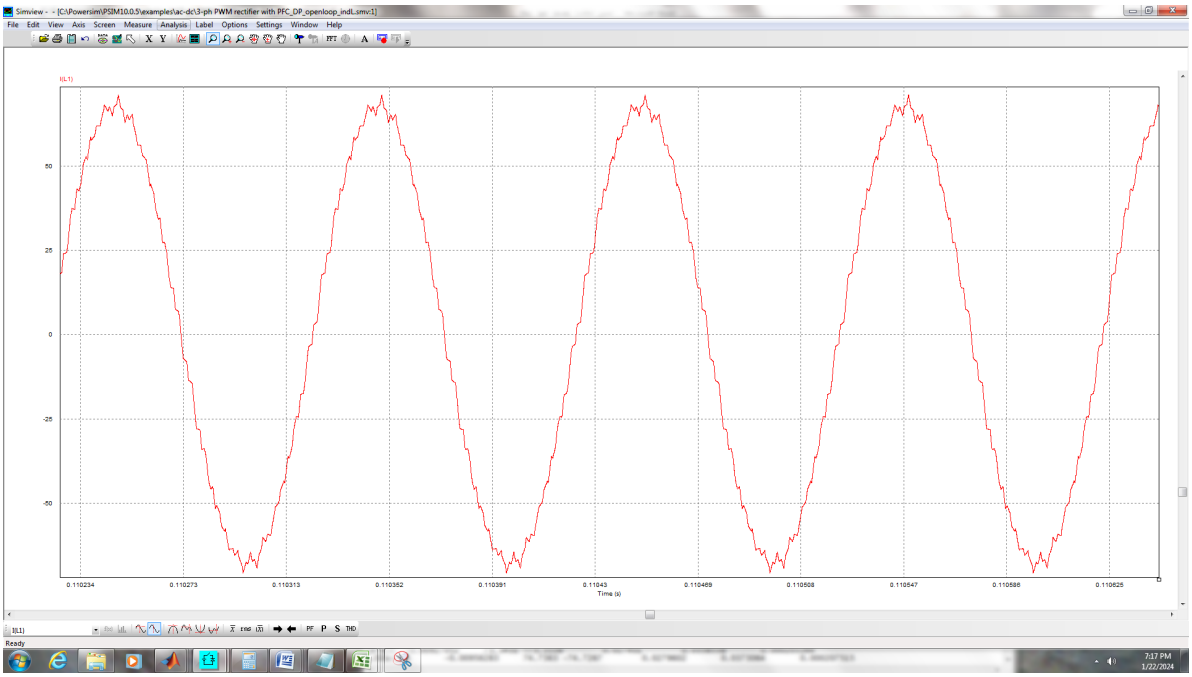
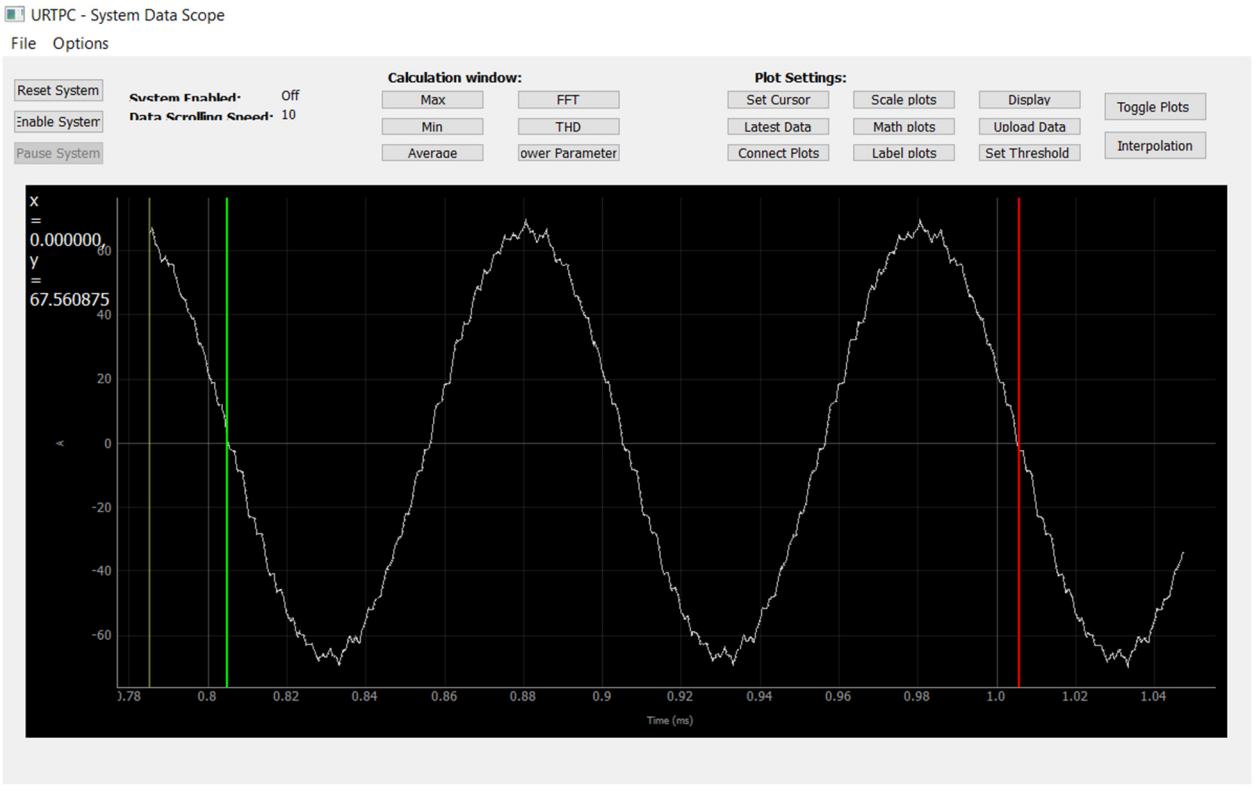


Fig. 16 The schematic of the 3-phase power converter as implemented in PSIM and URTPC simulator at 10kHz fundamental and 200kHz switching frequency with 24ns step size

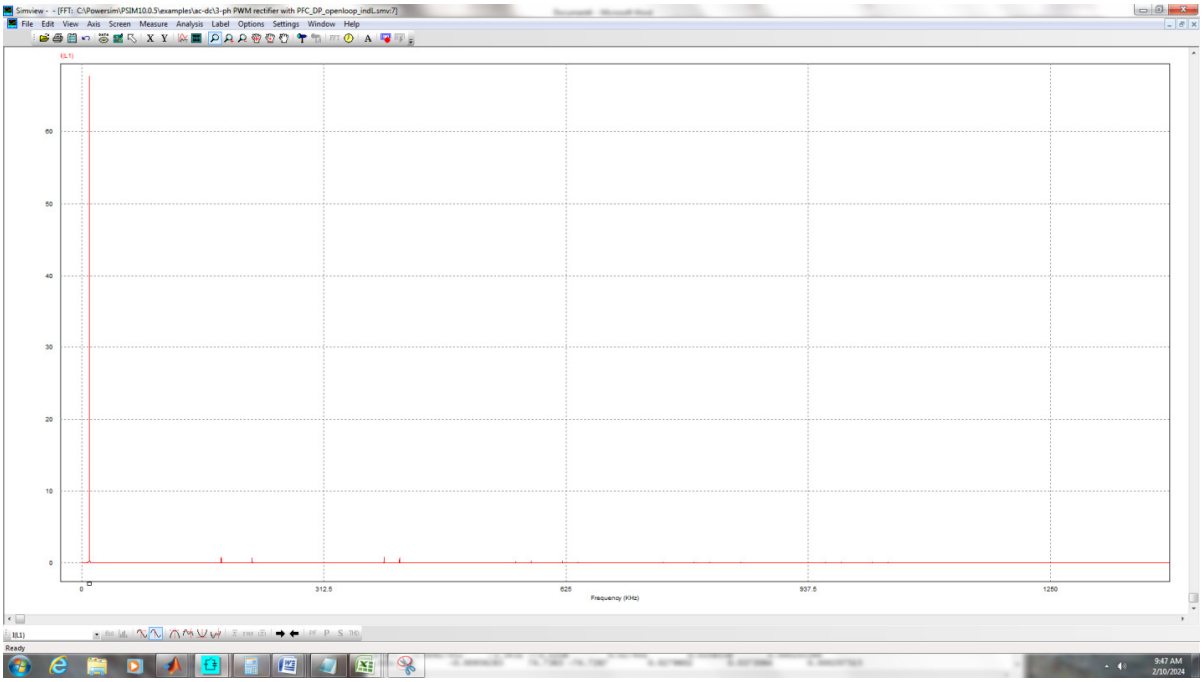


(A)

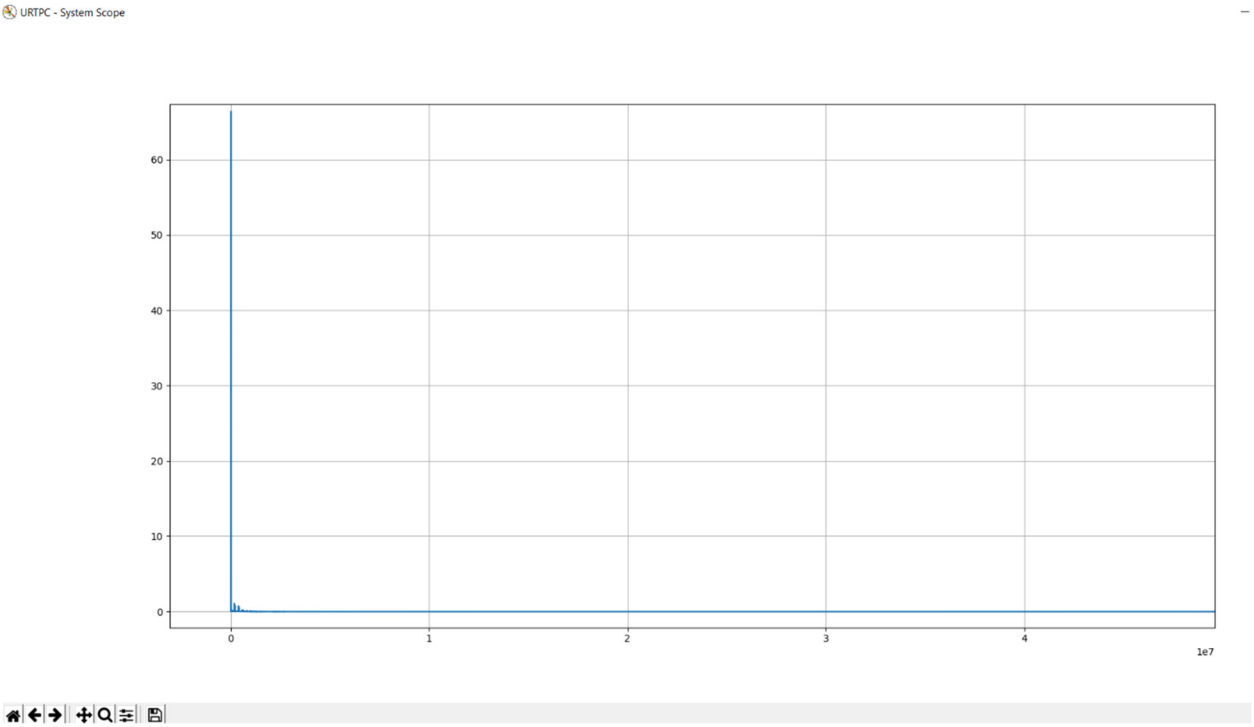


(B)

Fig. 17 Waveform of Phase current with PSIM (A) and URTPC (B) at 10kHz fundamental and 200kHz switching frequency with 24ns step size

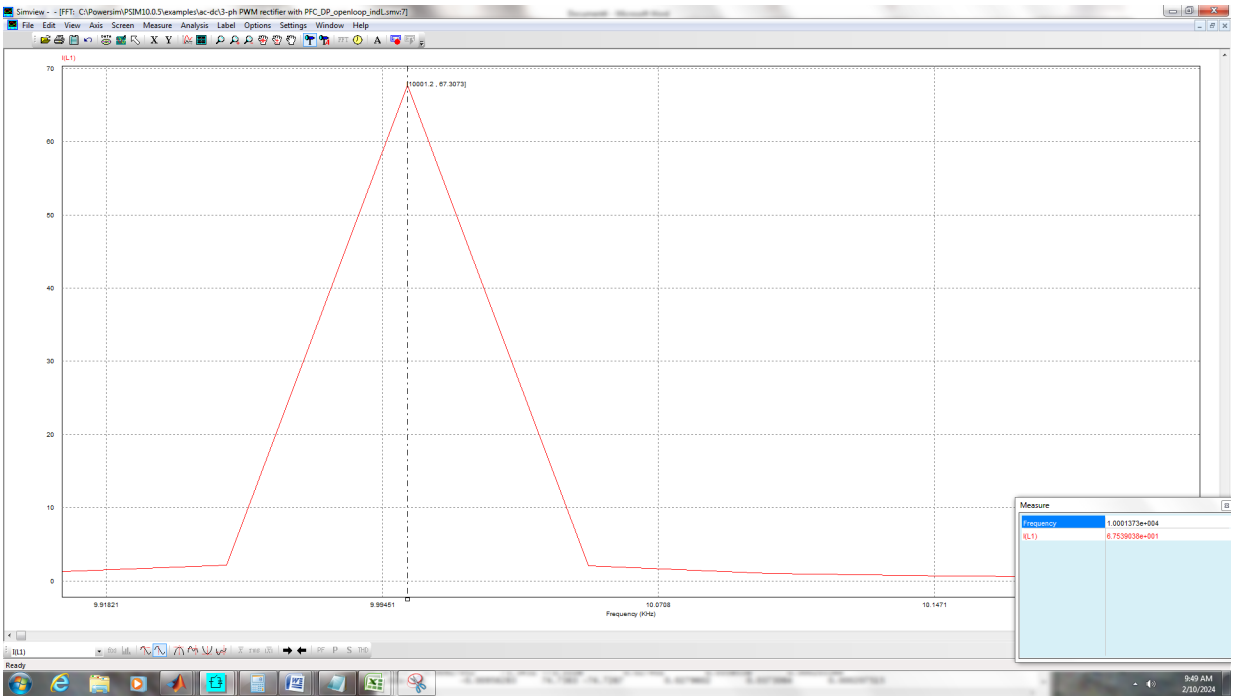


(A)

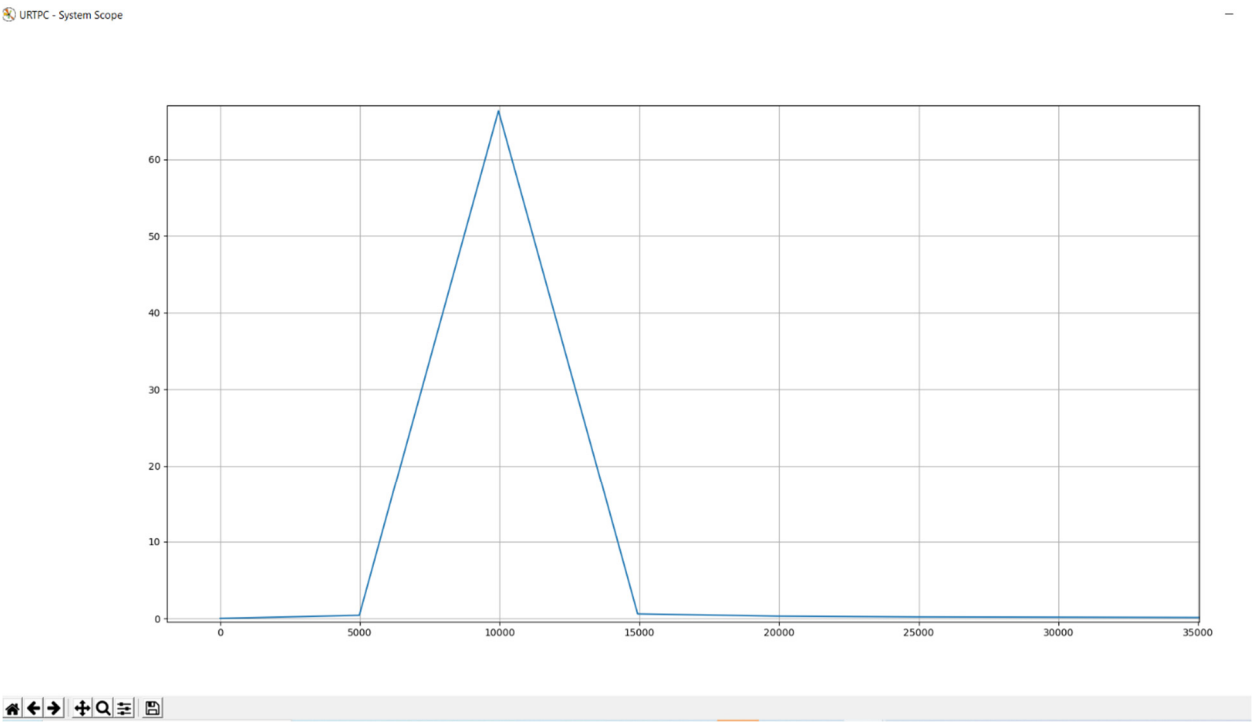


(B)

Fig. 18 FFT of full spectrum of Phase current with PSIM (A) and URTPC (B) at 10kHz fundamental and 200kHz switching frequency with 24ns step size.

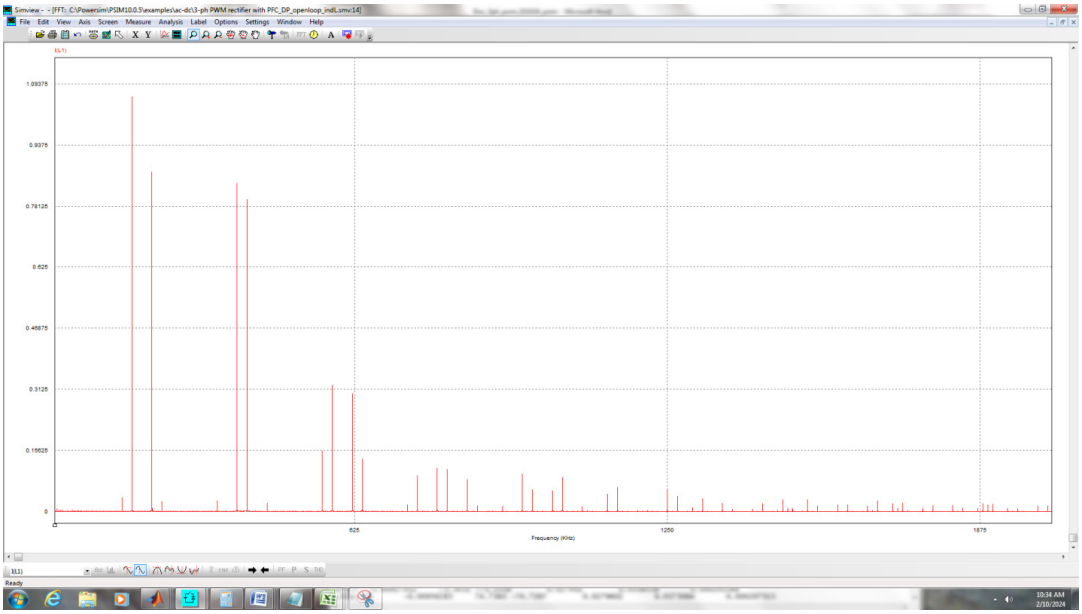


(A)

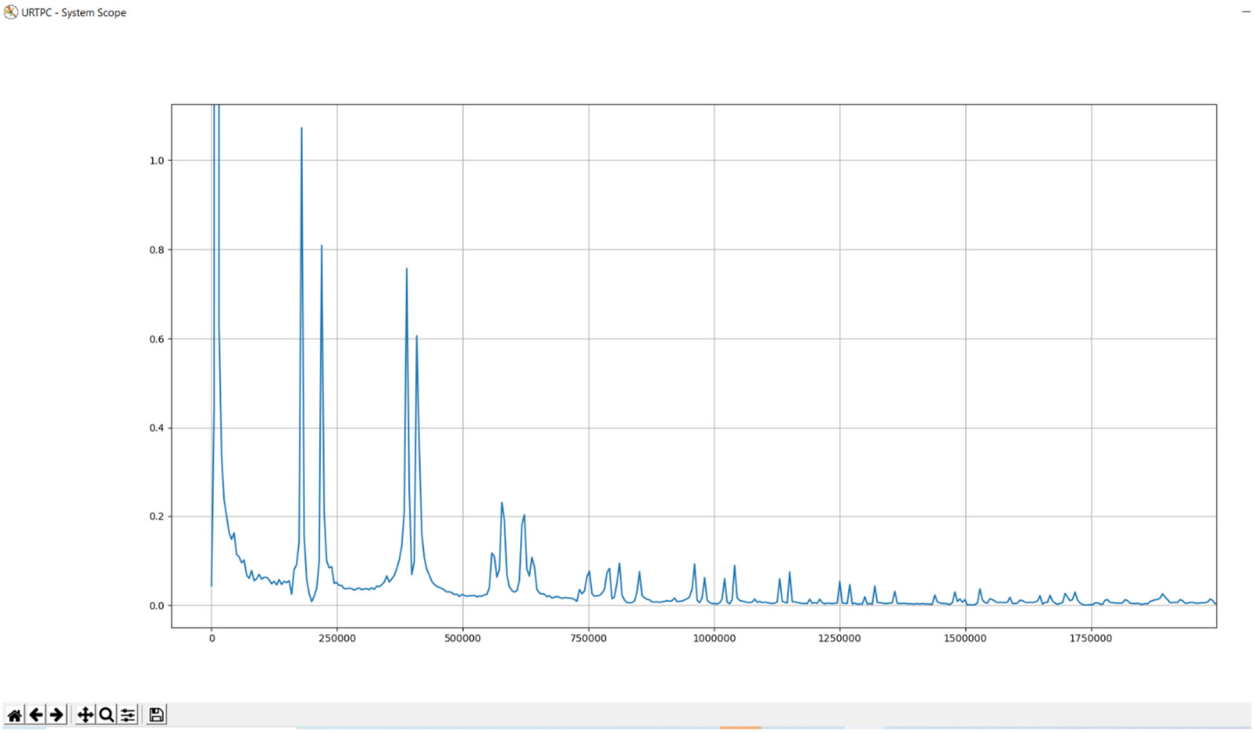


(B)

Fig. 19. FFT of the fundamental of Phase Current with PSIM (A) and URTPC (B) at 10kHz fundamental and 200kHz switching frequency with 24ns step size.



(A)



(B)

Fig. 20 FFT of the harmonics in Phase current with PSIM (A) and URTPC (B) at 10kHz fundamental and 200kHz switching frequency with 24ns step size.

References:

1. FPGA-based solver | Real Time modeling | eHS (opal-rt.com)
2. Power electronics control testing in real-time | OPAL-RT
3. FPGA Simulation | Real Time modeling | eHS (opal-rt.com)