

MIDDLE EAST TECHNICAL UNIVERSITY

Electrical & Electronics Engineering

Simulation Project #1

EE 463

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Introduction

In this project, we are asked to design and simulate Single Phase Diode rectifier with different load types, i.e. R, RL, RC. Also, THD analysis will be done for that circuit. For real applications, commercially available products will be chosen and analyzed as well.

Q1) Single Phase Diode rectifier is built for Turkish Grid (400Vl-l and 50 Hz) system. Since single phase diode rectifiers are connected to line to neutral, 230Vpeak is applied to the system.

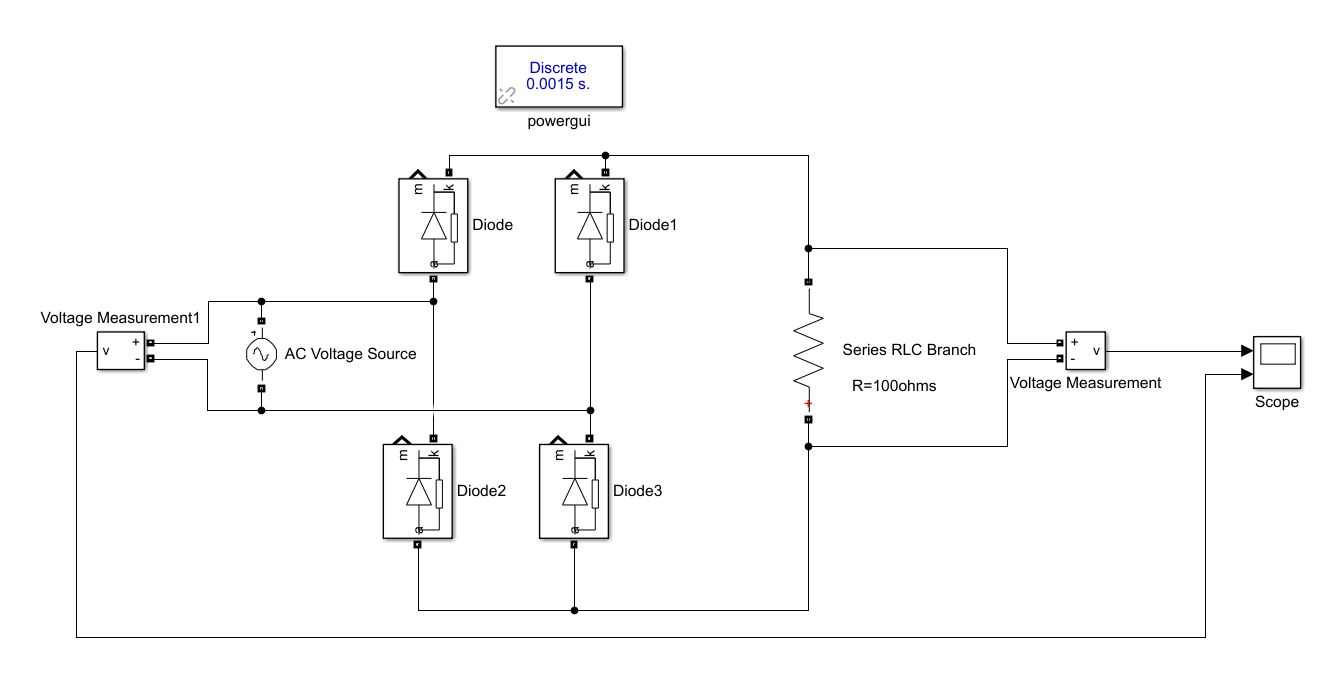


Figure 1: Single Phase Diode Rectifier with RLOAD = 100 Ω.

As seen from Fig.1, 4 diodes are used with load resistance 100Ω. At first, I was having trouble with simulation in Simulink because I did not add ‘powergui’ GUI into the simulation subblock. Powergui is used for simulating any Simulink model containing Simscape™ Electrical™ Specialized Power Systems blocks. It stores the equivalent Simulink circuit that represents the state-space equations of the model.

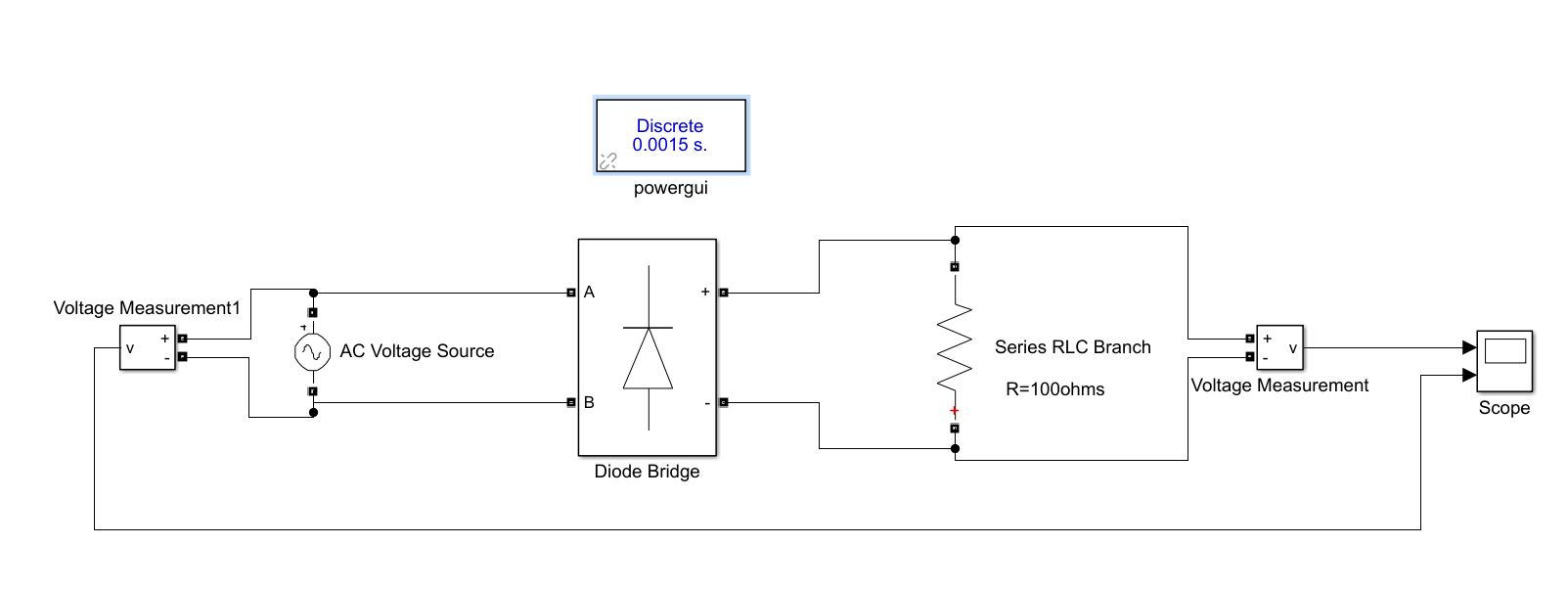


Figure 2: Single Phase Diode Rectifier with Diode Bridge and RLOAD = 100 Ω.

Later on, I tried using Diode Bridge Rectifier subblock for simplification purposes. The subblock is shown in Fig.2. The simulation results are same with the model in Fig.1.

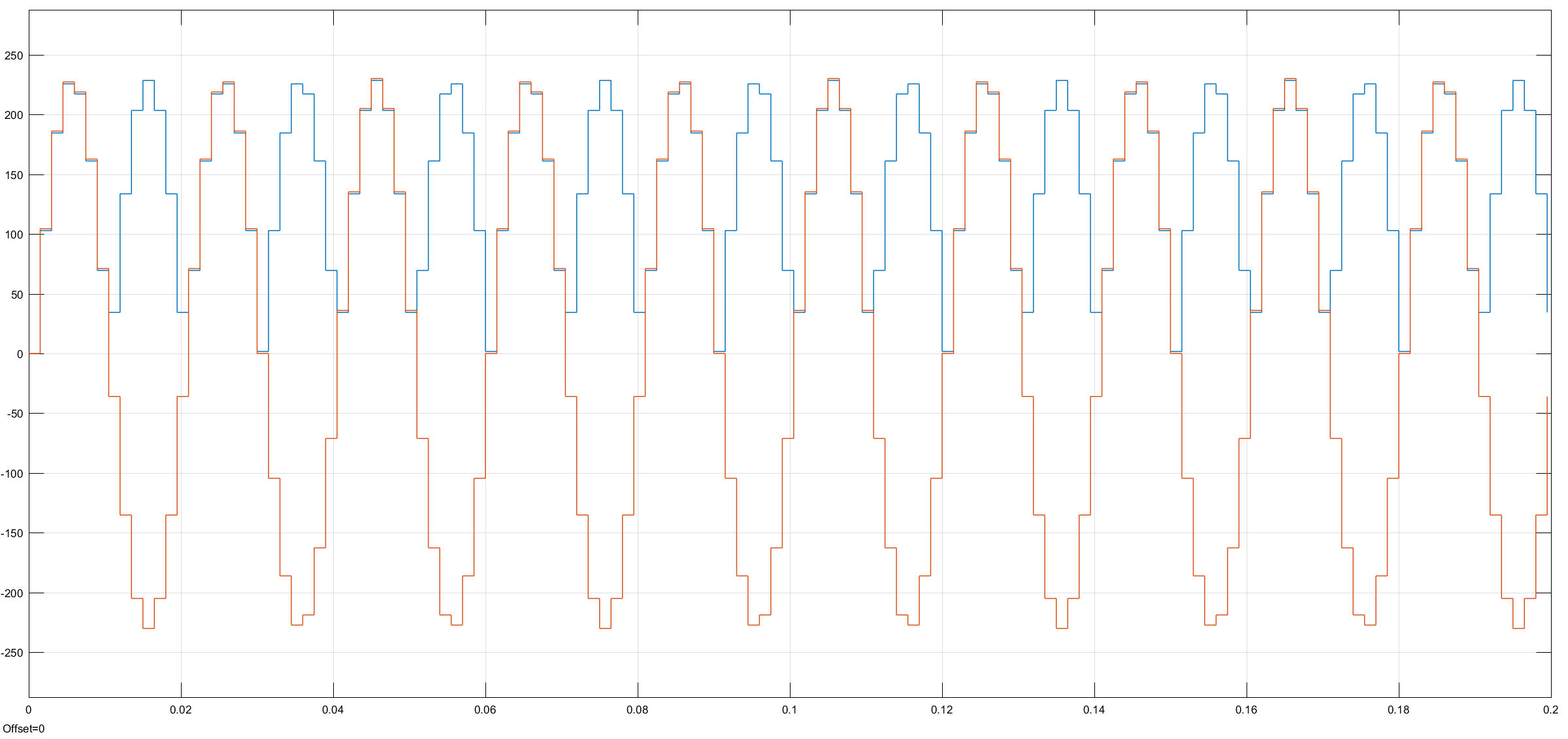


Figure 3: Input and output voltage waveforms of SPD Rectifier with step size 1.5mS

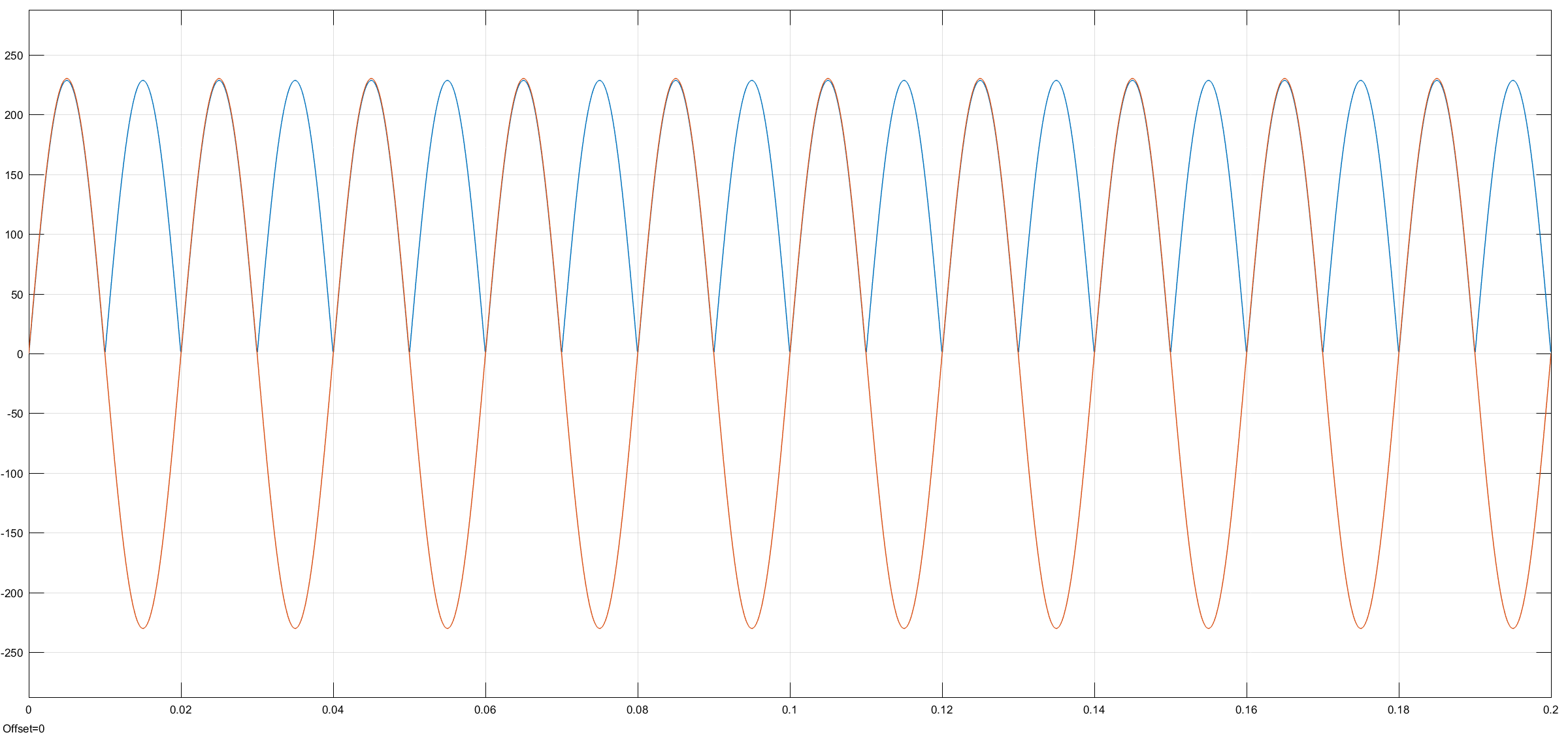


Figure 4: Input and output voltage waveforms of SPD Rectifier with step size 10µS

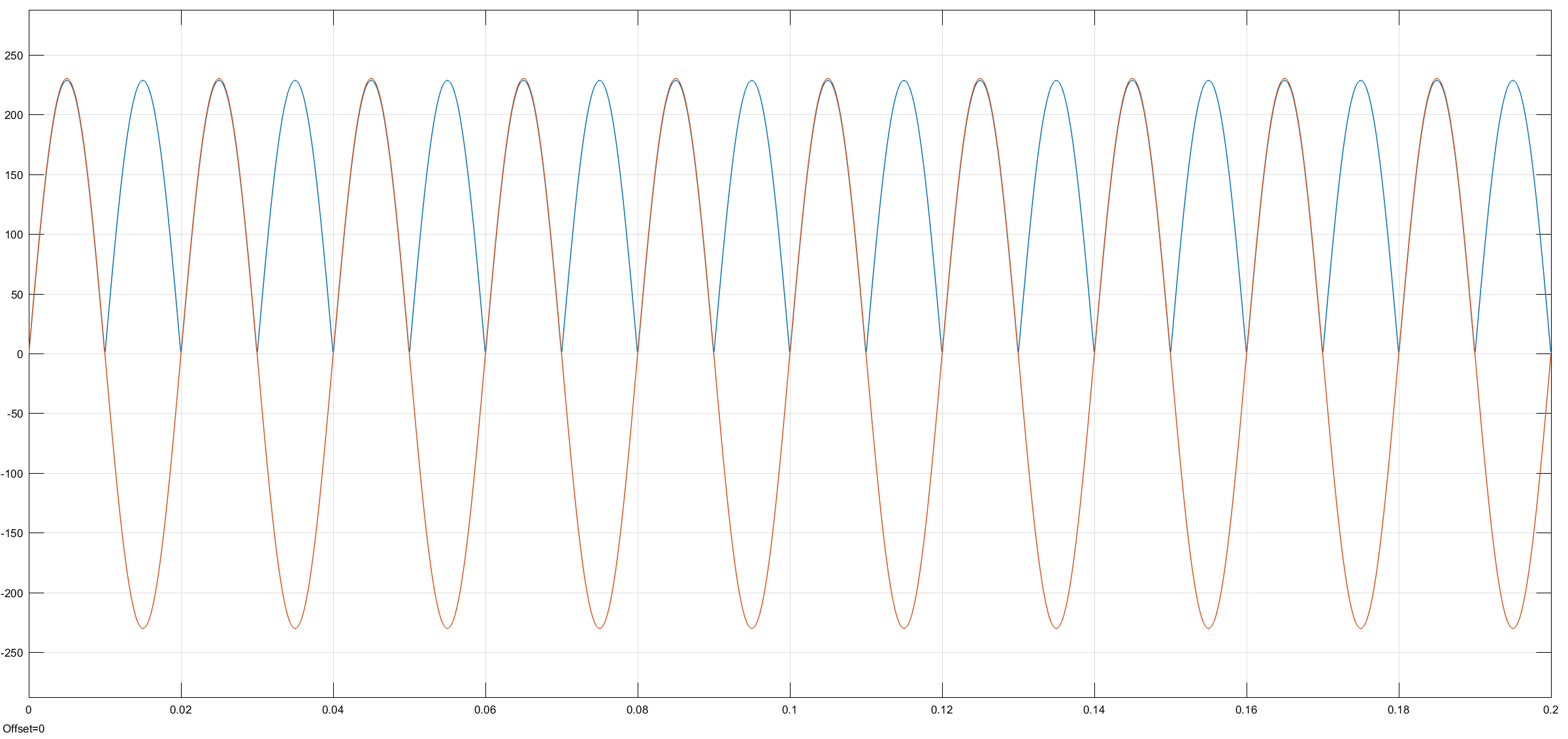


Figure 5: Input and output voltage waveforms of SPD Rectifier with step size 1µS

When we decrease the step size, the simulation results become more realistic because we are taking samples with narrow time intervals. This helps us to simulate the system very much a like to continuous system. It can be easily seen from Fig.3, Fig.4 and Fig.5 that decrease in the step size means more realistic analysis in continuous domain. The drawback here is microprocessor should work faster and we force it to work harder by increasing sampling rate.

Q2) The step size is taken as 1µS for this question.

2-1.

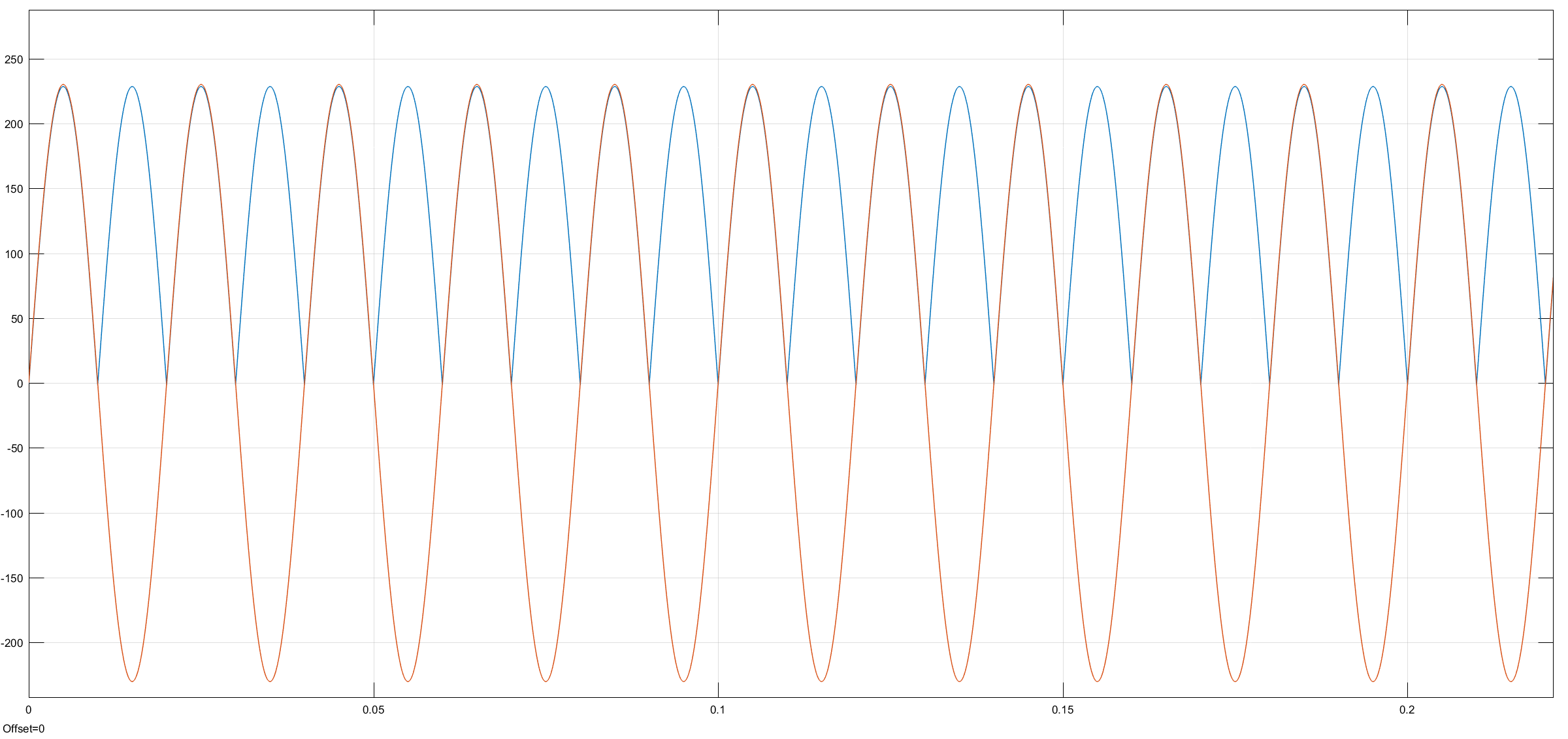


Figure 6: Input and output voltage waveforms of SPD Rectifier with RLOAD 25Ω.

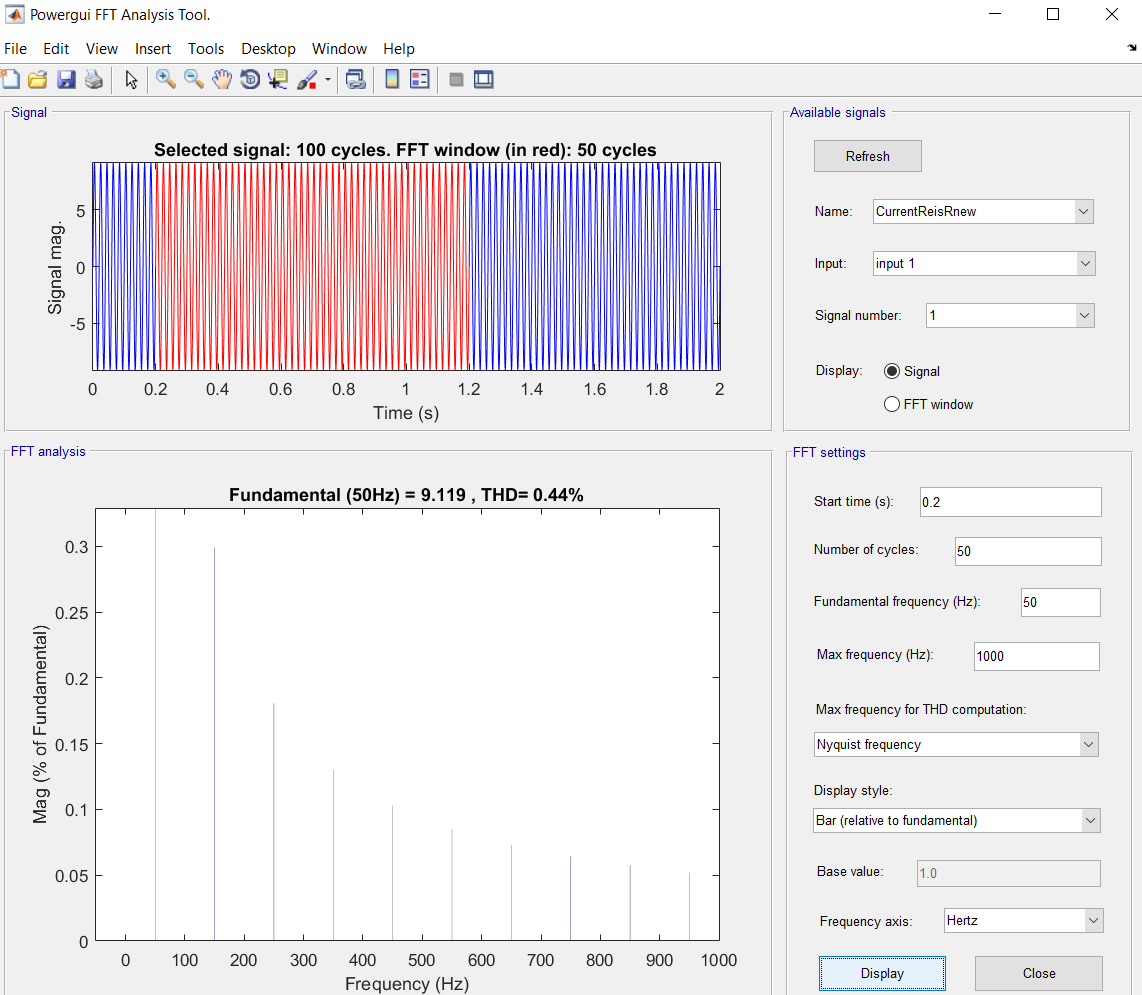


Figure 7: THD of SPD Rectifier

with RLOAD 25Ω.

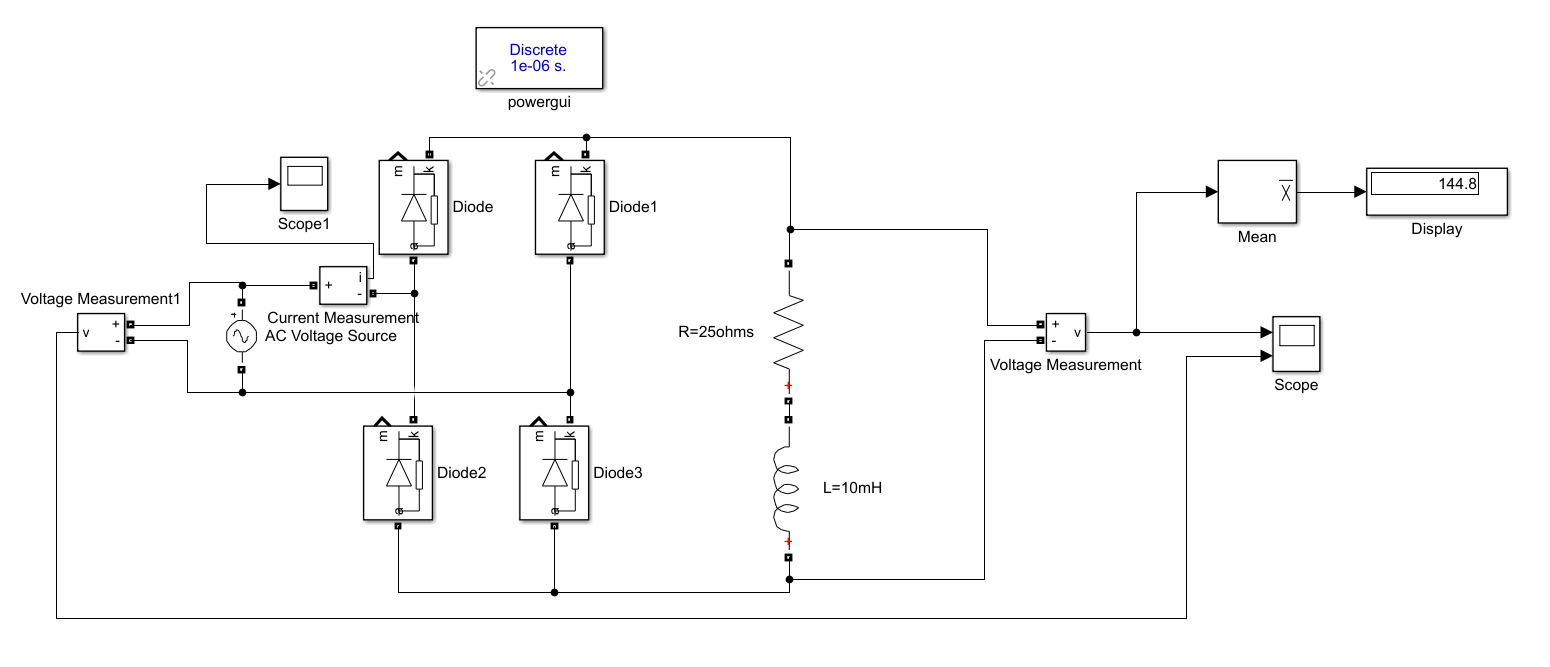


Figure 8: Circuit simulated for RL Load

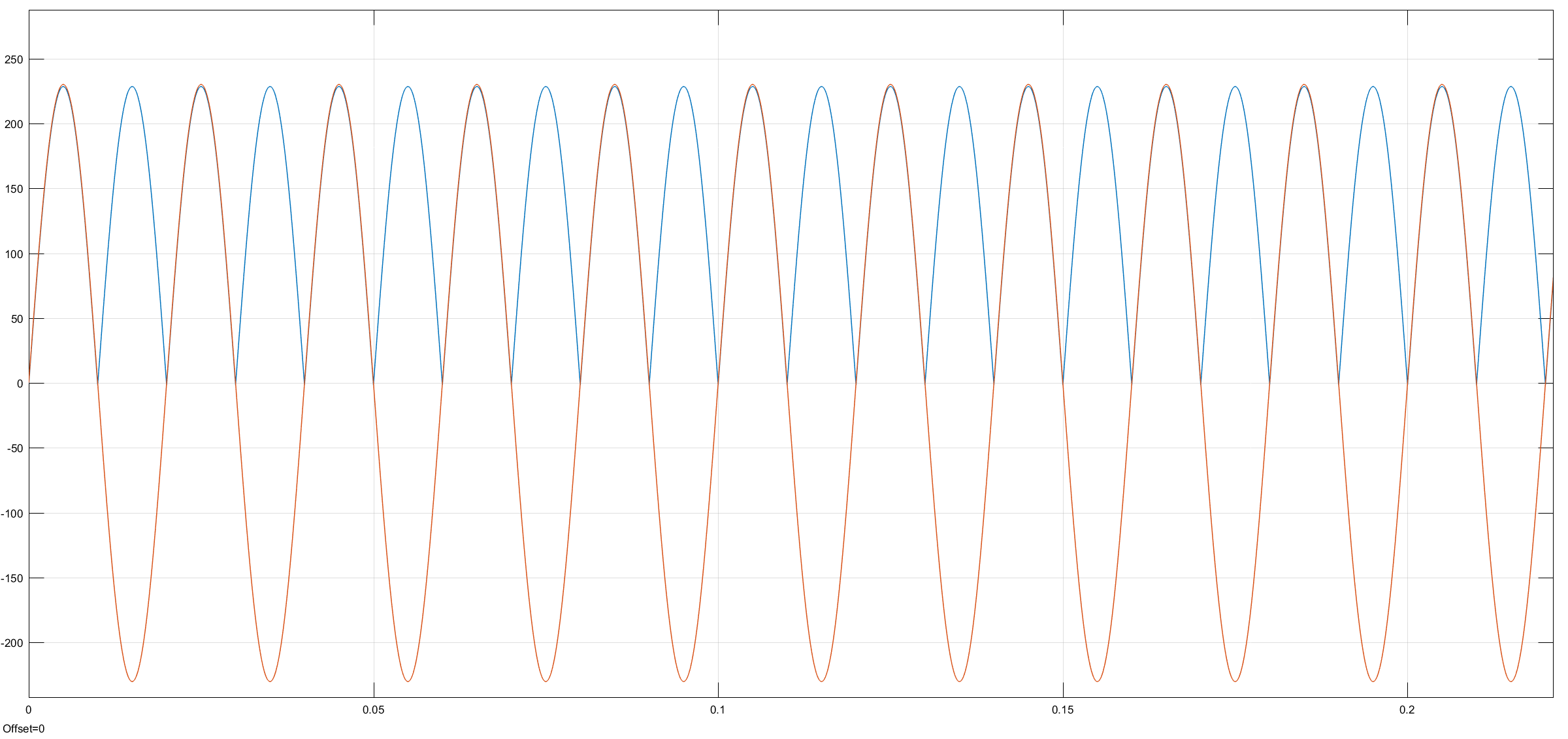


Figure 9: Input and output voltage waveforms of SPD Rectifier

with RLOAD 25Ω and LLOAD 10mH.

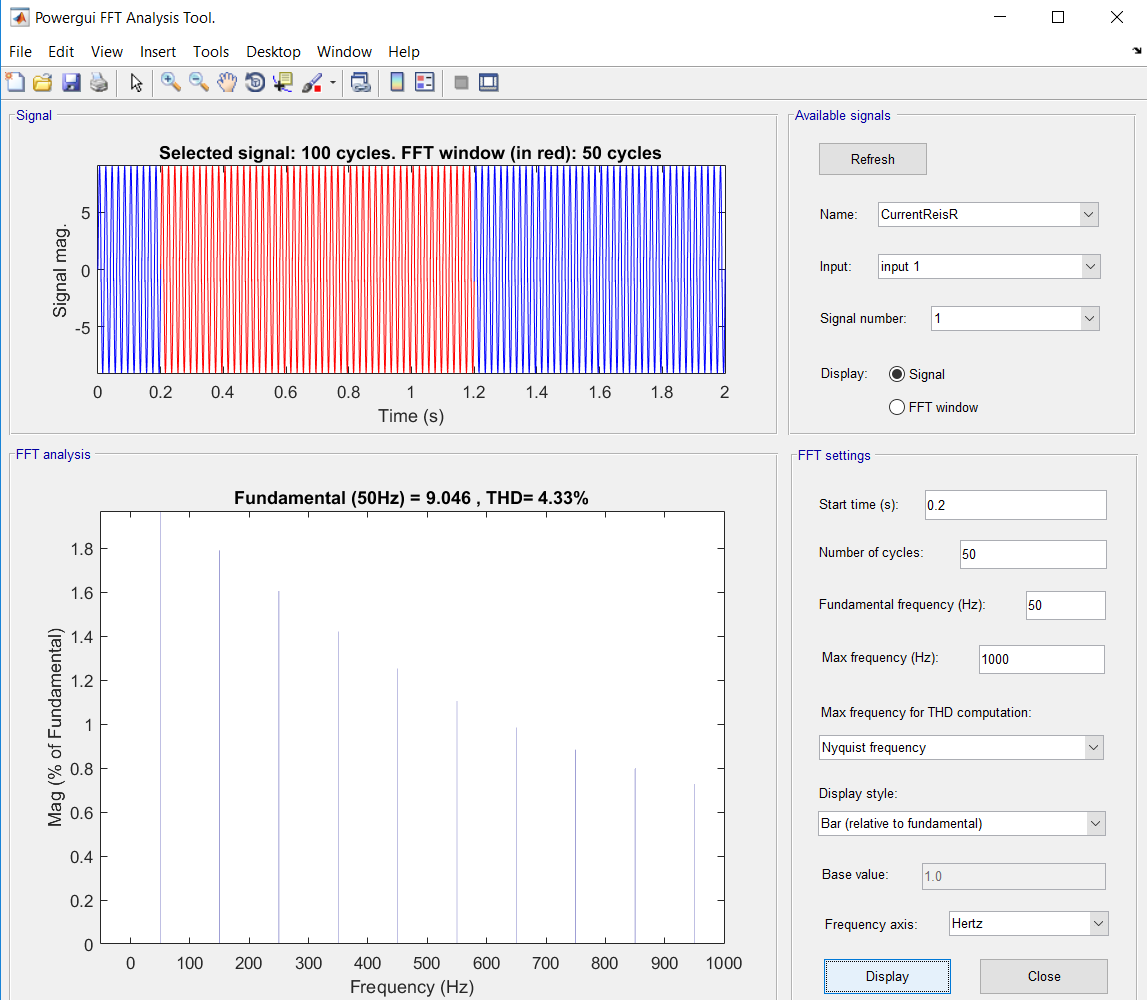


Figure 10: THD of SPD Rectifier

with RLOAD 25Ω and LLOAD 10mH.

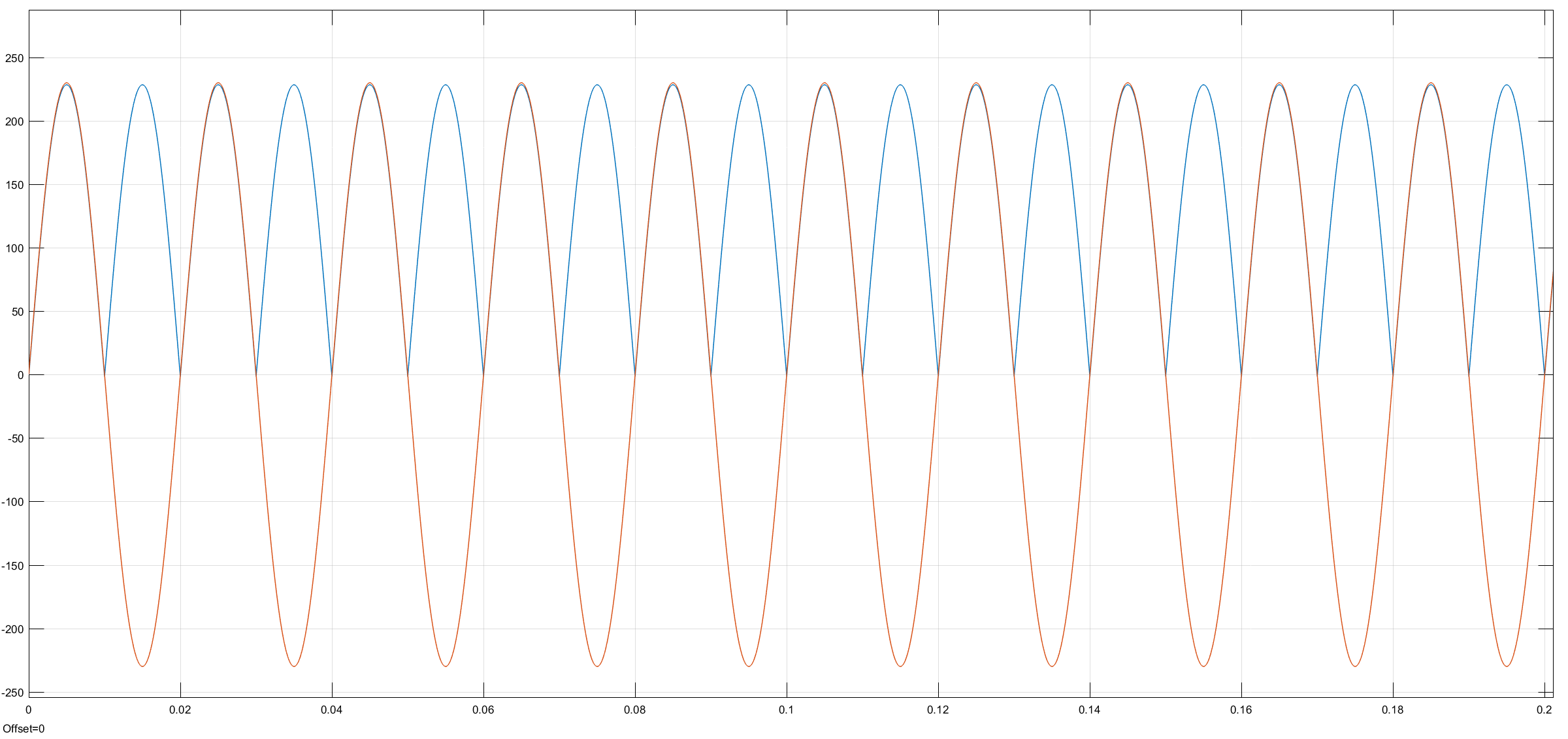


Figure 11: Input and output voltage waveforms of SPD Rectifier

with RLOAD 25Ω and LLOAD 1H.

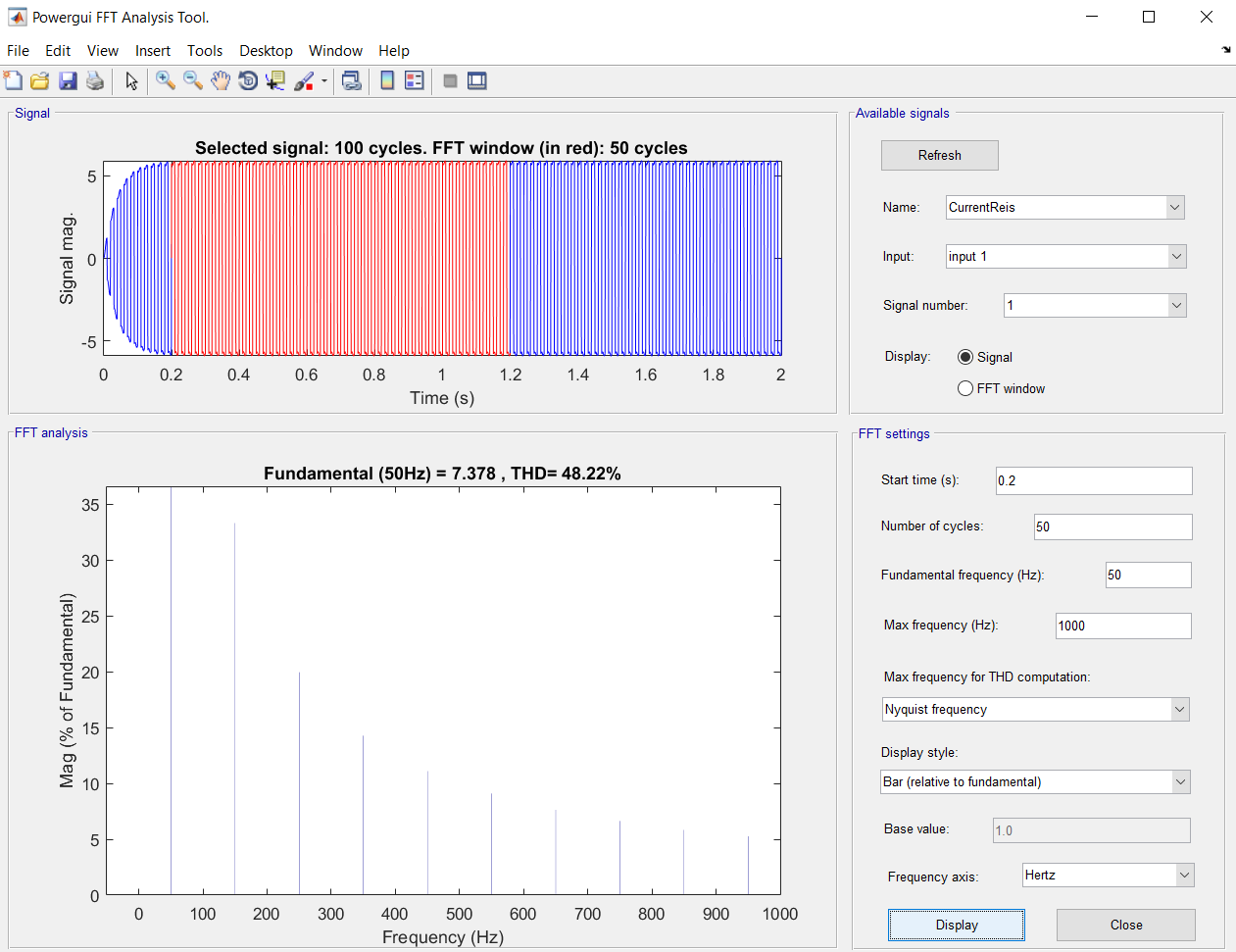


Figure 12: THD of SPD Rectifier

with RLOAD 25Ω and LLOAD 1H.

In conclusion, it is realized that THD of the line currents increases as we increase the inductance values at the load which implies when the current drawn from the load is more likely to ideal current source, THD increases. It can be also seen from the current waveforms that when we increase the inductance value, line current changes its form from sinusoidal to square. That is the reason why THD increases. Also, note that when we have 1H of inductance which is slightly higher value, we can behave load as ideal current source as in ideal it is infinity inductance. Hence, THD of 1H load is found as %48 which we also found in the lecture mathematically.

When the average values are considered, in all cases with different types of loads, VMEAN are same and equal to 144.8V as it is measured from the Mean block of the Simulink. It concludes that even the inductance value is increases, average voltage is not affected from it and it stays constant.

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