EE450 - Electronic Control of Motors

Lab 4 - Simulink Full Wave Rectifier

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Abstract

This lab is the recreation of a full wave rectifier using a video reference as a guide. The results and following modifications are to test the limitations and parameters that are contained within the model. They are used specifically only for analyzation of the model and not used for any other means.

Procedure

In the video, we were tasked with creating a full wave rectifier based on the design illustrated in the video provided. The video parameters were specified with just having a load containing resistance from a 100Ω resistor. From there the following results were emitted. As per request and modification purposes to understand the model and its limitations were to change the load once to have a capacitance and again to have inductance. From there input voltage will be modified and compared to the original, to see how each component directly/indirectly affects the overall circuit.

Design Model Results

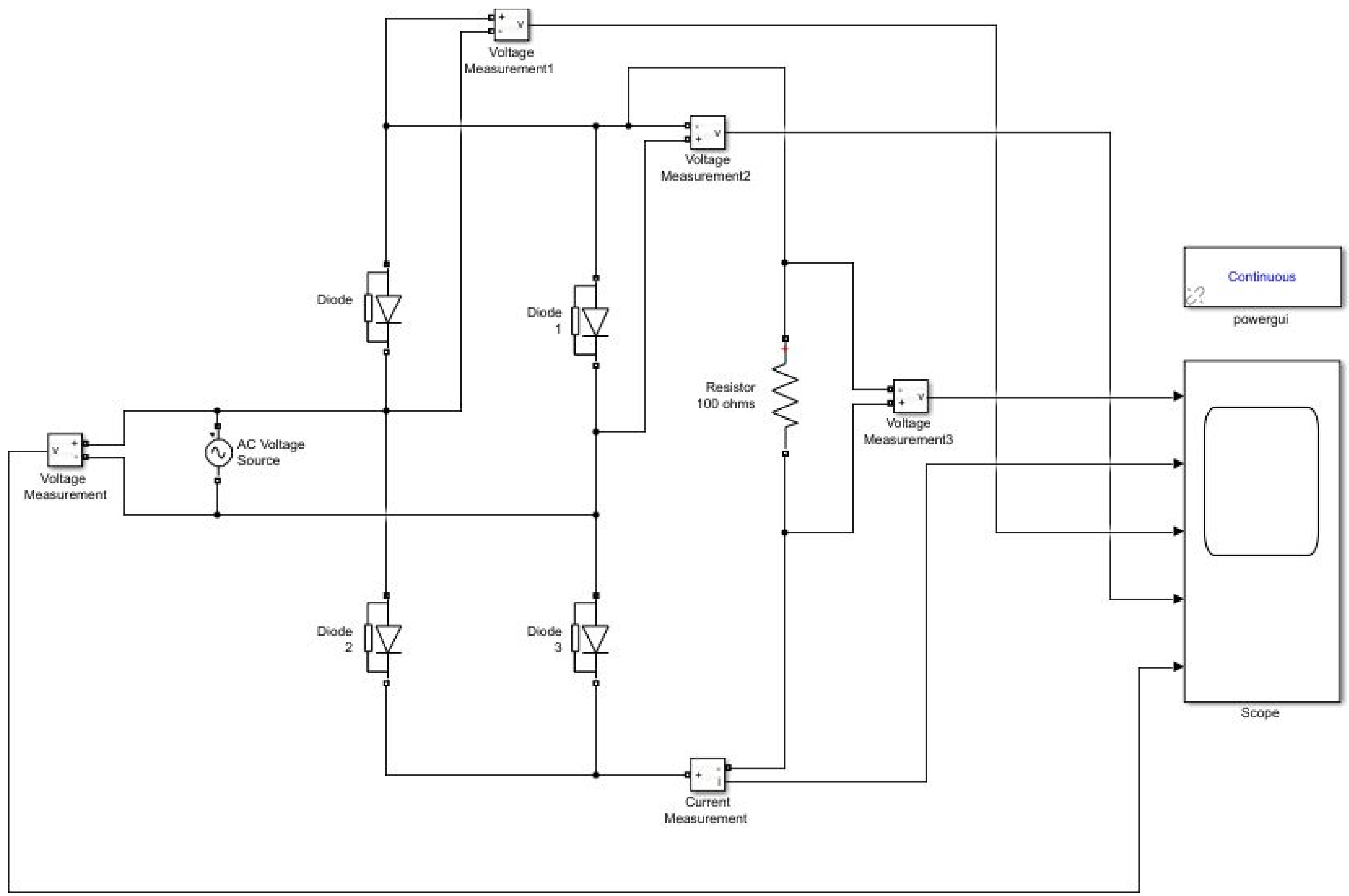

Figure 1: *Design model as of construction of the video file provided*

Figure 1 Note*: Some of the voltage/current blocks are flipped to make the final design easier to prospectively look at.*

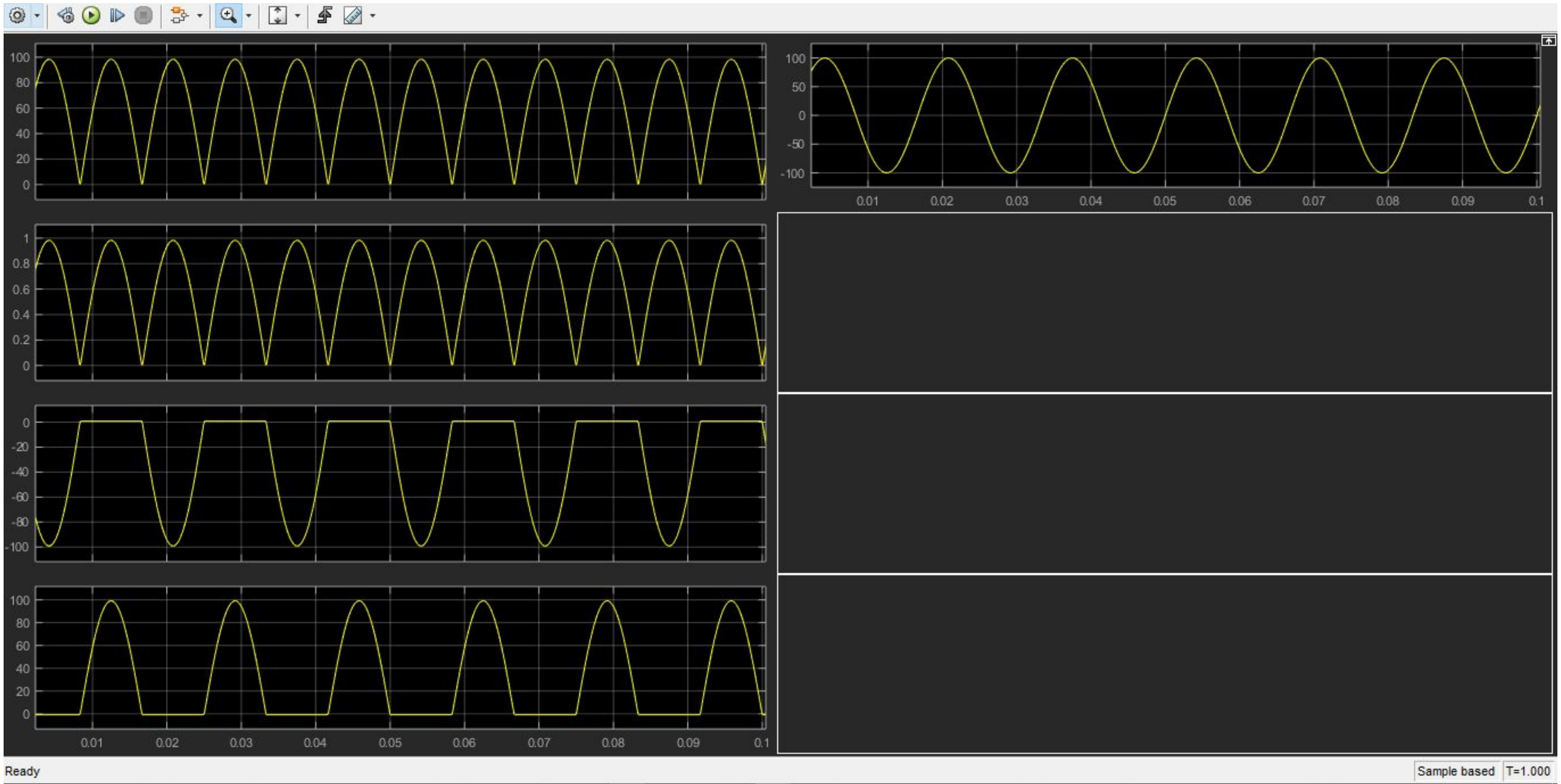

Figure 2: *These are the results of the Simulink in terms of voltage and current measurement*

For the simulation of the regular system, the top left most plot is the voltage measurement across the load, the next one below is the current measure measurement, the 3rd is the voltage measurement across the upper left diode, the bottom left is the voltage measurement is the voltage measurement across the upper right diode, and the last measurement on the right is the voltage measurement across the AC voltage input. For the plots, the 1st plot has only an positive output response across the load, as the wave are above zero and have no negative phase when crossing zero. This is also the same for the 2nd plot, but the current amplitude is reduced by 10 fold due to being directly proportional alongside the reactance. The 3rd only gives a negative feedback response to the system, and nulls out when crossing zero. These nulled out phases are flipped and responded across the 4th plot where the 3rd plot's nulled phases are positive phases and the 3rd plot's negative phases are the nulled phases on the 4th plot. This is because in the wave sequence across the full-wave rectifier they work in parallel and the opposite react inversely across the other. The last plot on the right is the natural input and comes out as a sinusoidal waveform.

Design Model Modification Results

RC Modification

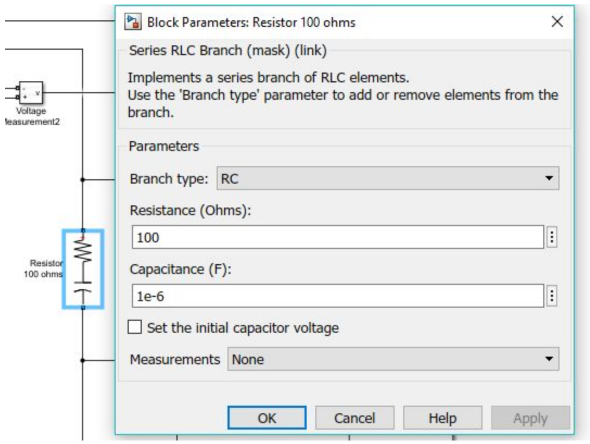

Figure 3: *This is the modification of turning the system into a RC load.*

The capacitance is added in series and adds directly to the resistance to the load. But since it is a capacitor, the series is added as 1/C.

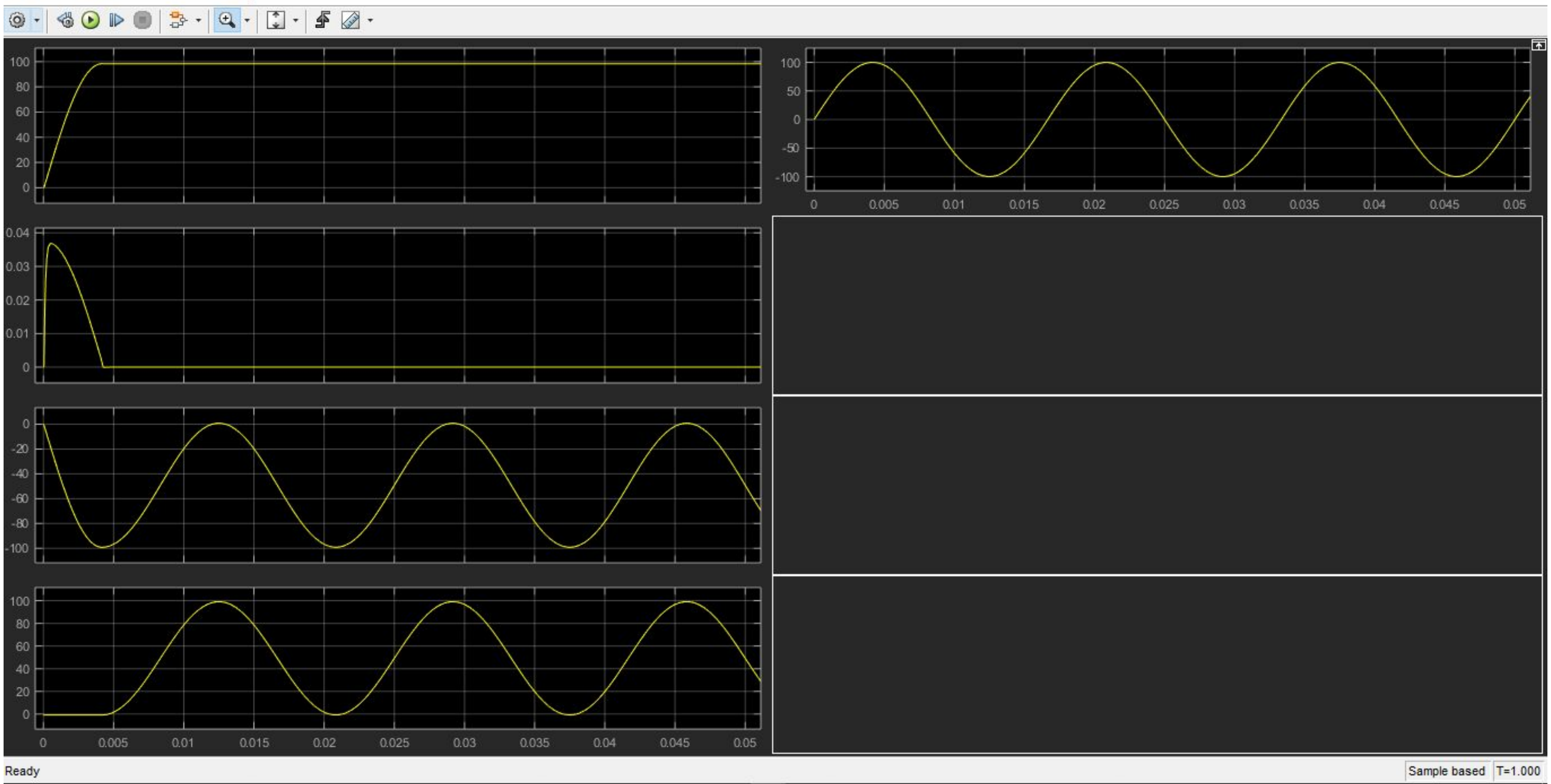

Figure 4: *This is the result of the system using a RC load.*

<u>RLC Modification</u>

The result of increasing resistance nullifies the crossing of the parallel in the two diodes' voltage as shown in plots 3 and 4. This in response of Ohm's law where the increased resistance directly affects the system's overall performance directly by raising the cutoff frequency to deny half wave responses in sections of the system. This change also shows the cutoff in the current as it peaks and then decays after a set amount of time. This peak and decay are reflected to a rise and consistent hold of the voltage as shown in the 1st plot. As for the voltage input, this is unaffected and does not change the plot on the right.

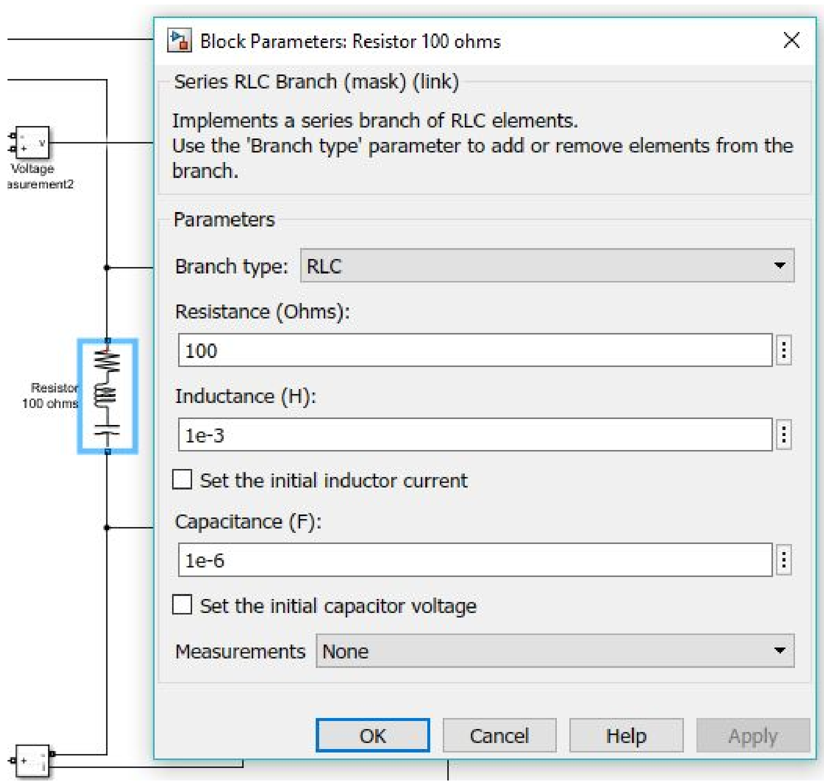

Figure 5: *This is the 2nd modification where there is an RLC load instead of R or RC.*

The change adds an impedance but differential change to the system in terms of load, and adds to the overall reactance.

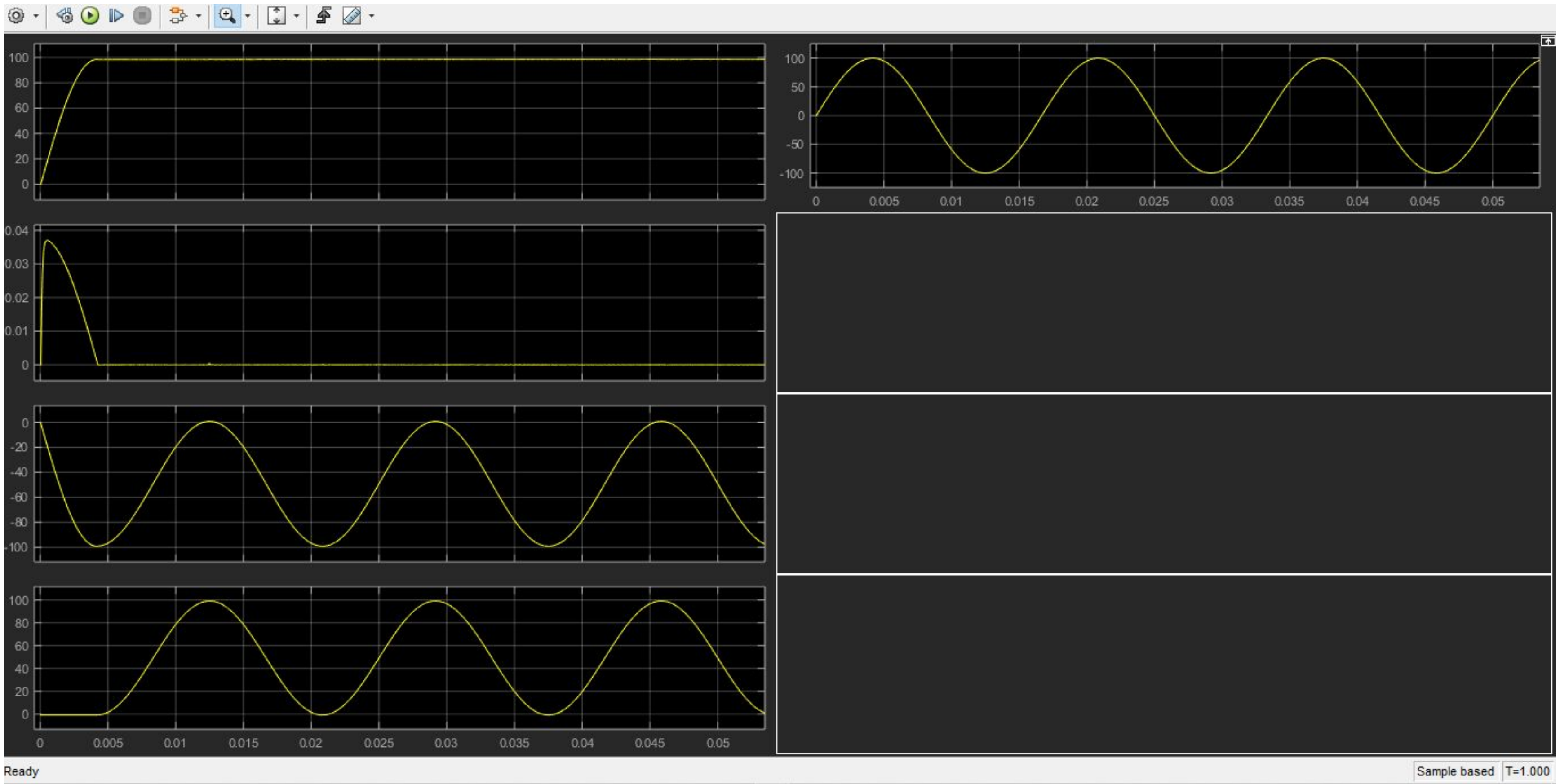

Figure 6: *This is the result as the RLC load is implemented.*

As result of the adding the load, the change in the voltage and current across the load is delayed. The time in the rise for the voltage measurement is delayed to reach maximum voltage. The current reach reaches the peak approximately at the same time, but the drop off rate is decayed and slowed down by the increased reactance that is now apparent in the system. This load increase doesn't fully affect the diode voltage and the input voltage. As result, the only real difference, is set across the resistive load current and voltage.

Voltage Modification

Here, the the voltage is modified to test variable changes in the system. The input is increased to 1M V from 100V, a factor of 10^5.

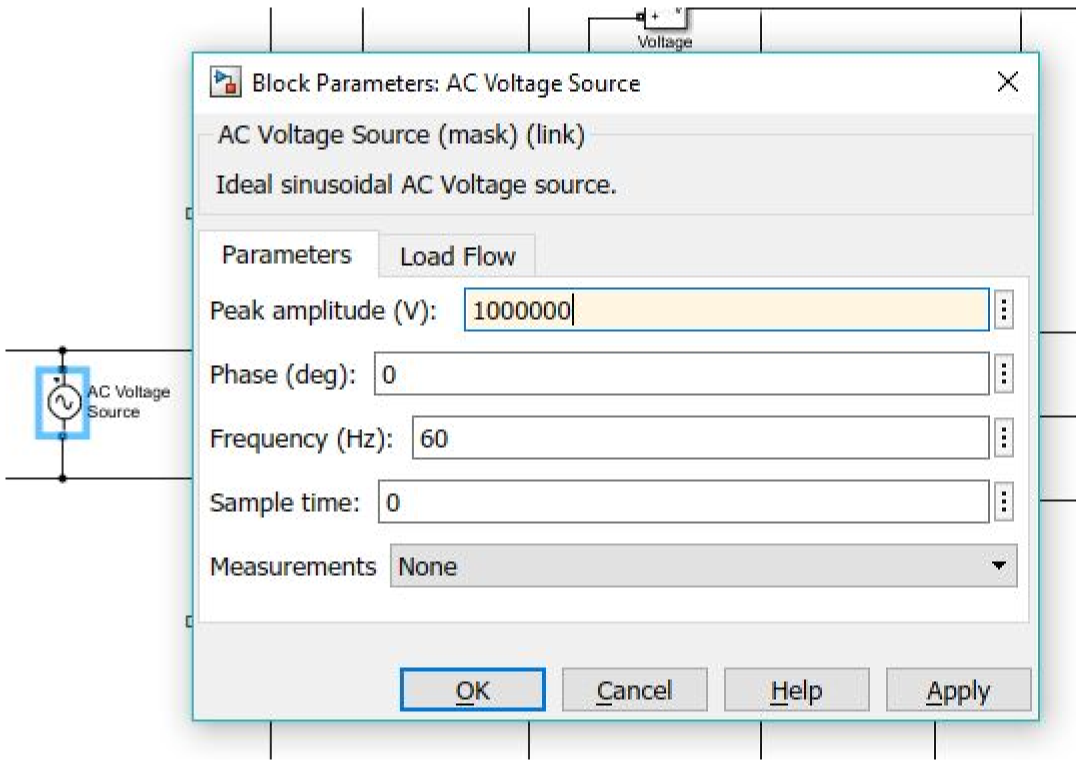

Figure 7: *While reverting back to the R load, the voltage input is increased by a factor of 10^4.*

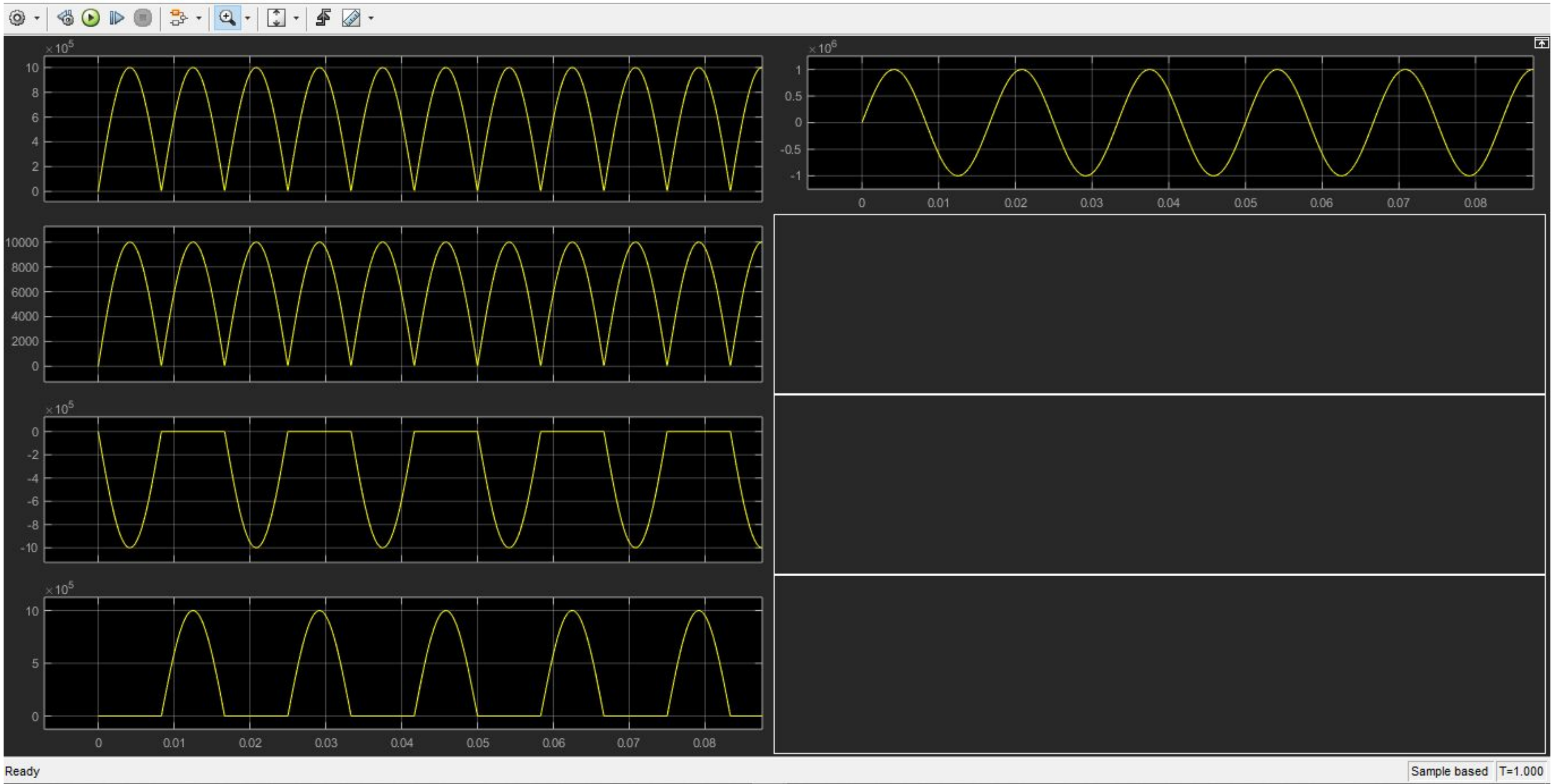

Figure 8: *This is the result as of running the system with the voltage increase.*

As result of the voltage increase, the only difference is the values. The general shape remains the same and the values are stretched to a 10^5 factor increased. The values are also set for only the amplitude values and the frequency values remain the same.

Conclusion

As result of the modifications of the full wave rectifier, the addition of load opens up the diode to double sided waves and removes the limiting factor of the waves, allowing for a for positive and negative values. As for the voltage input, if it is increased or decreased, the value is directly proportionally increased or decreased. For the current and voltage across the load, they are limited. The more load is applied into the system whether it is capacitance or impedance, the more the overall system is delayed in terms of the peak voltage and current.