RMS Power

ECE 4513

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Abstract:
Root mean square or RMS is average power of a signal and can be computed using different methods. This report will demonstrate how to calculate the RMS value through simulation and using the equation in our lab manual. The values of each will be compared and the percent error will be calculated.

Introduction:
This lab was an introduction to the digital communication simulator MATLAB/Simulink. In this lab our task was to generate a compounded periodic signal and calculate the RMS value and compare it to the results we receive from creating a simulation. For this project we were to create a signal that was sinusoidal from 0 to N1*1 seconds with a peak amplitude of +A. The next segment of the signal was a constant amplitude of +A volts for N2*T seconds. The final segment was a signal with a constant amplitude of -A for the remainder of the period. N1 = .24, N2 = .44, A = 11 and T=.17 mSec were the parameters given to create the custom compounded signal.

Our task was to demonstrate that the simulink simulation generated the compounded sign. The next task was to manually calculate the RMS of our given signal. The running RMS block in Simulink was used in order to find the RMS of our signal.

Discussion
Manual RMS Calculations:

$$RMS^2 = 1/T \int_{-t/2}^{t/2} \left| s(t)^2 \right| dtV^2$$

Figure 1: Equation used to calculate RMS

To find the RMS of the compounded signal the equation in figure 1 was used. In order to find the integral of the signal three integrals were used, one for each segment of the periodic signal. The complete equation is shown below in figure 2.

$$RMS^2 = 1/.00017 * \left(\int_0^{.0000408} \left| 11^2 sin^2(2\pi * 5882t) \right| dt + \int_{.0000408}^{.0001156} 11^2 dt + \int_{.0001156}^{.00017} (-11^2) dt \right)$$

Figure 2: Shows the equation used to calculate the RMS.

The equation above will compute to

$$RMS^2 = 1/.00017 * (.0000204 - .00000618 + .0090508 + .0065824)$$

$$RMS = \sqrt[2]{5882 * (.016)}$$

$$RMS = 9.7$$

Simulation RMS:
The next step was to find the RMS using simulink.The first step was to create the one-quarter sinusoid with a frequency of 6127 Hz. In order to create this a sine wave is created with and multiplied with a square wave. This was accomplished by creating a square wave with a period of .00017 secs and have the pulse width of 24%. When these two signals are multiplied together the signal shown in figure 3 is created. Next the two segments with +A and -A are created, this signals will be created using a pulse generator. To create the required signal the period is .17 mSec with an amplitude of 11,pulse width of 44%, and phase delay of .0408 mSec. The next signal will have a amplitude of -11,pulse width of 32%, and phase delay of .0001156 mSec. These two signals are added together to create a single signal which is shown in figure 3.

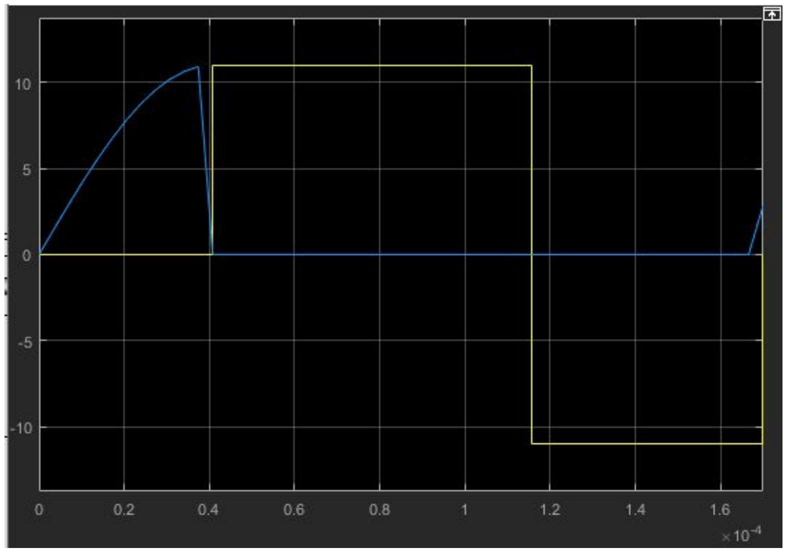

Figure 3: Shows the two signals that are created. The blue signal is the quarter sinusoidal wave and the yellow signal is the the two pulse signals added together.

The next step was to add the two figure shown figure 3 and create the final signal. Figure 4 shows the resulting addition of the two signals.

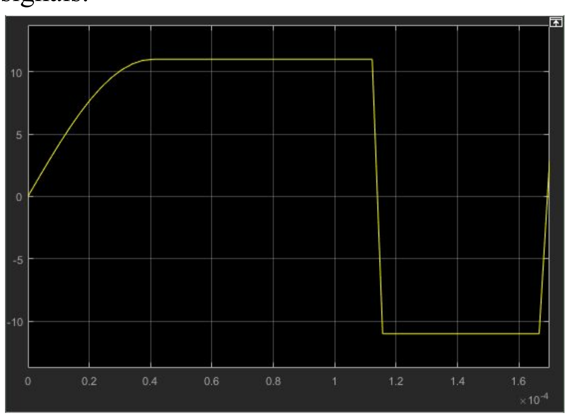

Figure 4: Shows the final compounded signal that we will find the RMS for.

All the blocks used are shown in figure 5 with the RMS value found as well. The RMS value found is 9.632.

Conclusions:

Calculating by hand and simulation provided an accurate reading of the RMS of our signal created. Based on the RMS of the simulation which was 9.632 and the calculated value of 9.7 the percent error was .7%. The value of the calculated RMS could change based on what decimal places were rounded to. This rounding could change the value of the number slightly. In the simulink model multiple scoops were used to ensure the proper waves were created.

Appendix:

The figure below shows the simulink model created for this project. Pulse 1 was the signal with amplitude of 11,pulse 2 had a amplitude of -11, and pulse generator2 was the signal used to create the quarter sine wave. Sine wave1 was the sine wave with frequency of 5882. The multiple scopes used were to ensure the proper signals were created. For example basic waves showed the 4 waves created,while truncated signals showed the two added square waves and the quarter sine wave. The final scope called scope shows the compounded wave.