

MULTISIM DEMO 8.1: INTRODUCTION TO RMS VALUES IN MULTISIM

It seems as we progress further and further into the use of Multisim we are using more and more complicated instruments. But we will relapse sometimes and use those basic “core” instruments even in the AC domain. That’s what this Demo is all about.

In order to measure RMS (root-mean-square) values of periodic signals, we can use a really simple piece of equipment: Our old friend, the multimeter.

Let’s analyze the simple circuit of a 1 Vpk, 1 kHz signal feeding into a 1 k Ω resistor. First we need to add an AC_VOLTAGE component. Note this is different than the AC_POWER component, even though the two have nearly identical symbols. The AC_VOLTAGE is found under

Group: Sources
 Family: SIGNAL_VOLTAGE_SOURCES
 Component: AC_VOLTAGE

(It is shown in Fig. 8.1.1 for reference).

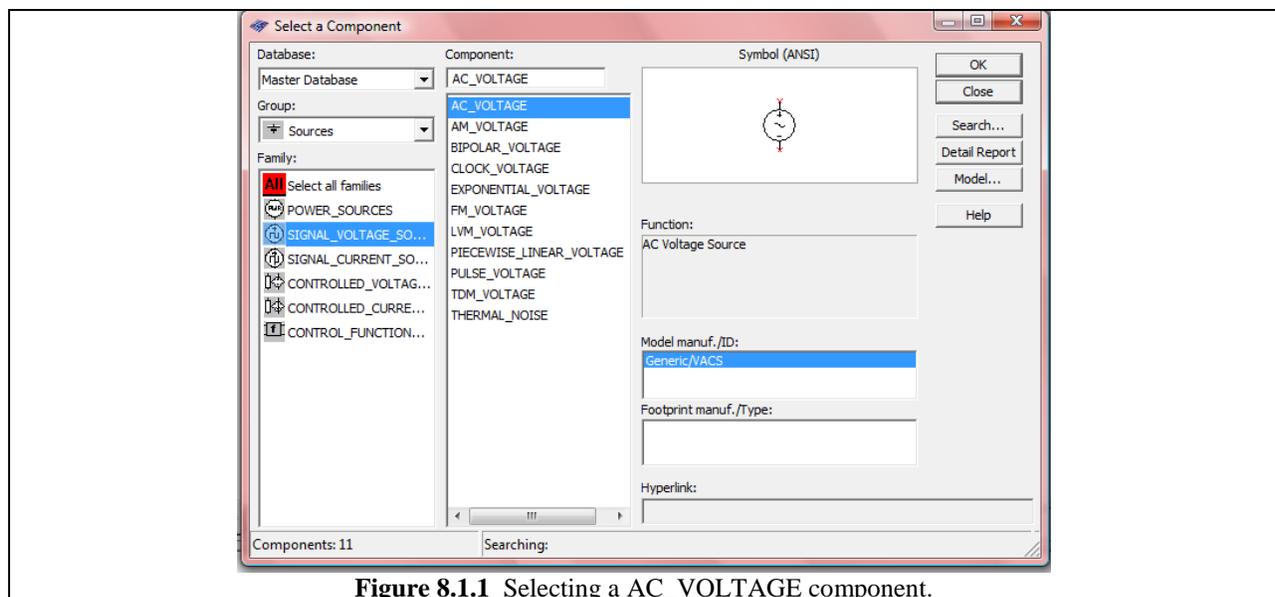
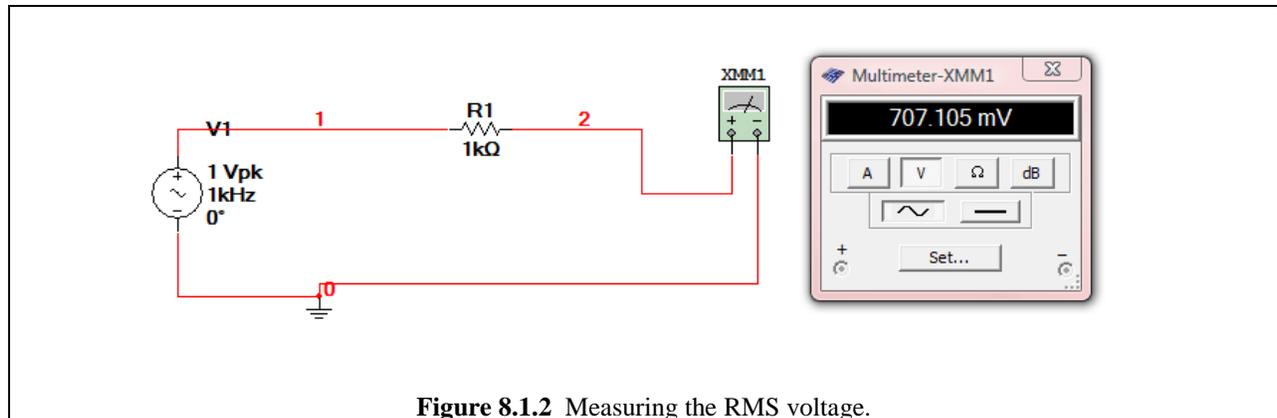


Figure 8.1.1 Selecting a AC_VOLTAGE component.

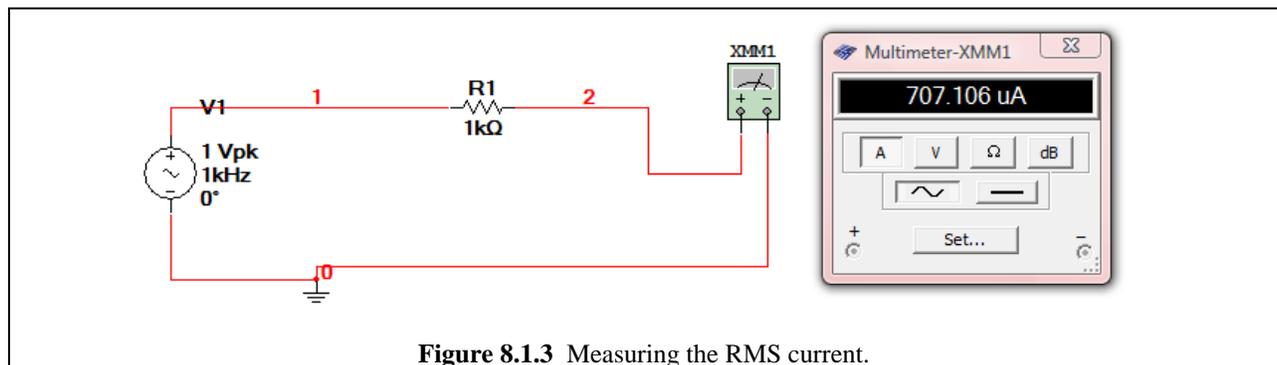
Double-click to bring up the properties window for the AC_VOLTAGE. If it isn’t set to 1 Vpk, change it to that. Also, make sure it is at 1 kHz. Connect the Multimeter across the circuit as shown in Figure 8.1.2 on the next page and add a ground. Note that we are not measuring the voltage across the resistor in the standard parallel way, but are instead breaking the circuit. This is acceptable in this case because there is only one component in the circuit; the voltage we measure will be what is placed across the resistor.

Open up the Multimeter window. Click on the  to set it to AC, and make sure it is set to measure voltage. Start the Interactive Simulation by pressing F5 or by pressing the  button on the simulation toolbar. The simulation should look like that shown in Figure 8.1.2.



As we can see in Figure 8.1.2, the value provided by the Multimeter is 707.106 mV, which is equal to the Vpk value divided by the square-root of 2. This is the RMS value...what we wanted! So the lesson here is that the Multimeter provides us with the RMS value of an AC signal.

Now let's measure the current through the resistor using the multimeter. While keeping it on the AC setting, enable the current measurement by pressing the "A" button. Since the voltmeter measures RMS voltage, it is probably safe to assume that the ammeter measures RMS current.



As we can see in Fig. 8.1.3, the value provided by the Multimeter is 707.106 μA . This makes sense, because the resistor has a value of 1 k Ω . so:

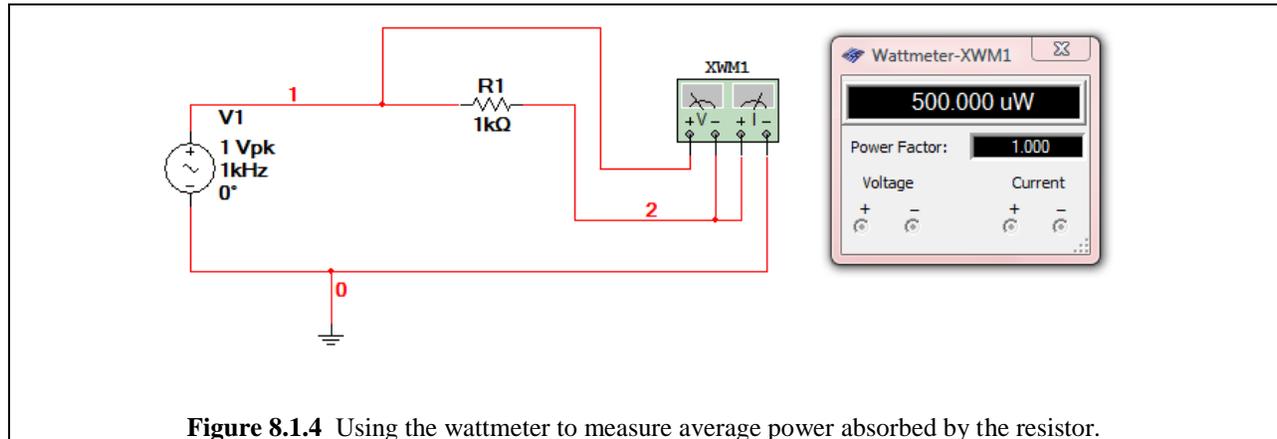
$$I_{rms} = \frac{V_{rms}}{R} = \frac{0.707105}{1000} = 707.105 \times 10^{-5} \text{ A}$$

Indeed we do get the RMS current. Everything is in agreement!

So now we've just measured the RMS voltage and current. What about power? In the AC world, power is no longer a single real value, but instead is complex. In Multisim, the only real way to easily get the entire complex power quantity is through variable manipulation in one of the Analyses such as AC Analysis (See Demo 8.2), but we can use the Wattmeter instrument in Interactive Simulation mode to provide us with the real component (P_{av}) of complex power S .

In AC, the Wattmeter measures Average power dissipated or supplied. Remember, that it does not provide a sign on its measurements so there is no way of knowing if an arbitrary black box portion of a circuit is absorbing or dissipating power.

Incorporate the Wattmeter into the circuit just as if the circuit were DC. When you're ready, run the Interactive Simulation. The result should look like that shown in Figure 8.1.4.



In looking at Fig. 8.1.4, we see that the wattmeter is measuring 500 μW . This makes sense, because in the first two measurements, the RMS voltage was found to be 707.105 mV and the RMS current was found to be 707.106 μA . Since the load is entirely real the power equations simplify to :

$$P_{av} = V_{rms} \cdot I_{rms} = 707.105 \times 10^{-6} \cdot 707.105 \times 10^{-6} = 500.00 \times 10^{-6} \text{ W}$$

These values are only so useful. Once we start dealing with complex impedances, the Wattmeter, the Voltmeter, and the Ammeter will only be telling us part of the story. See Demo 8.2 on how to deal with complex power in the general case.