Simple RC Project for the Electronics Explorer Board

Revision: March 11, 2011
**Note:** This document applies to REV D&E of the board.

This project demonstrates some basic features of the Digilent Electronics Explorer Board. Using just a resistor and a capacitor, the project introduces the Arbitrary Waveforms Generator and Scope instruments in the WaveForms software as well as the Bode Transfer Function. To keep the project simple for new users, only a few features of the software are used.

To generate an RC circuit step response showing the time domain:
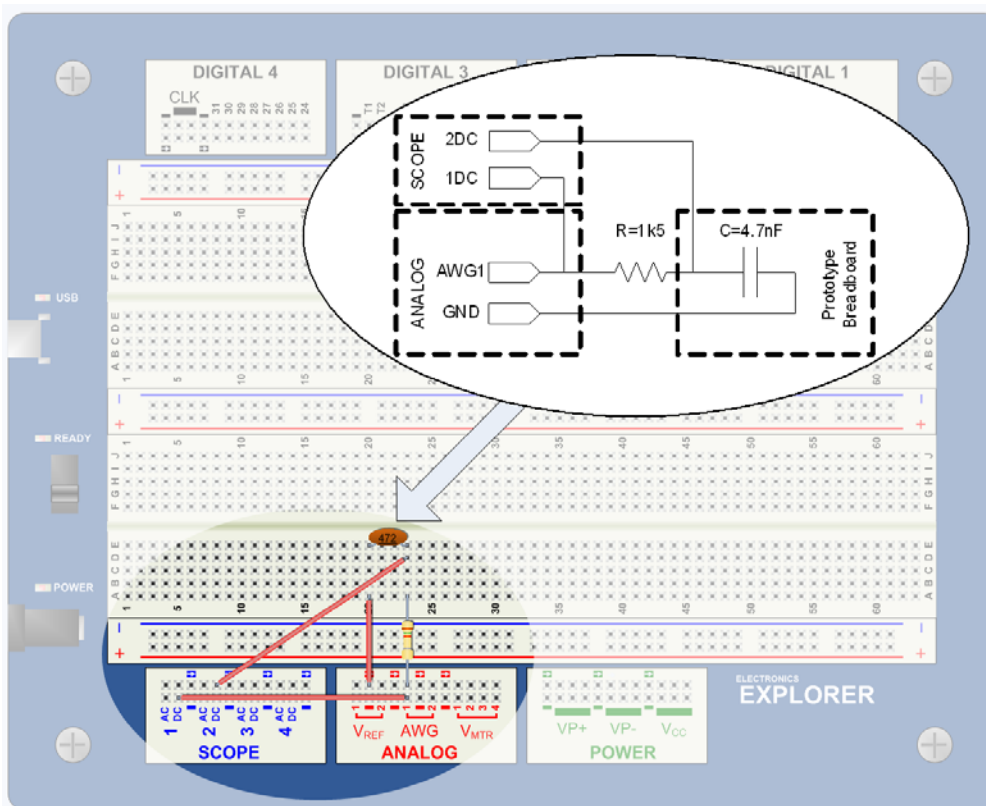

1. Build the schematic above.
2. Connect the EE Board to the PC with a USB micro AB cable.
3. Connect the board power supply.
4. Turn the On-Off switch ON.
5. Launch the WaveForms software.
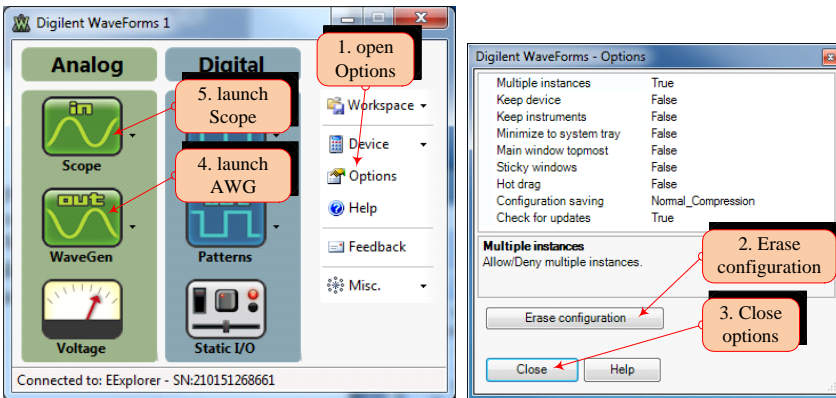
6. When closing, WaveForms stores the last configuration (by default). To restore the factory default settings, click Options in the WaveForms main window, then click Erase Configuration in the Options window. Close the Options window.

7. Launch the Arbitrary Waveform Generator (AWG).

8. Launch the Scope.

9. In the AWG window, set the excitation signal for the RC circuit: Shape = rectangular, Frequency = 1kHz, Amplitude = 5V, Offset = 5V, Symmetry = 50%, Phase = 0. Click Run All or Run AWG1.
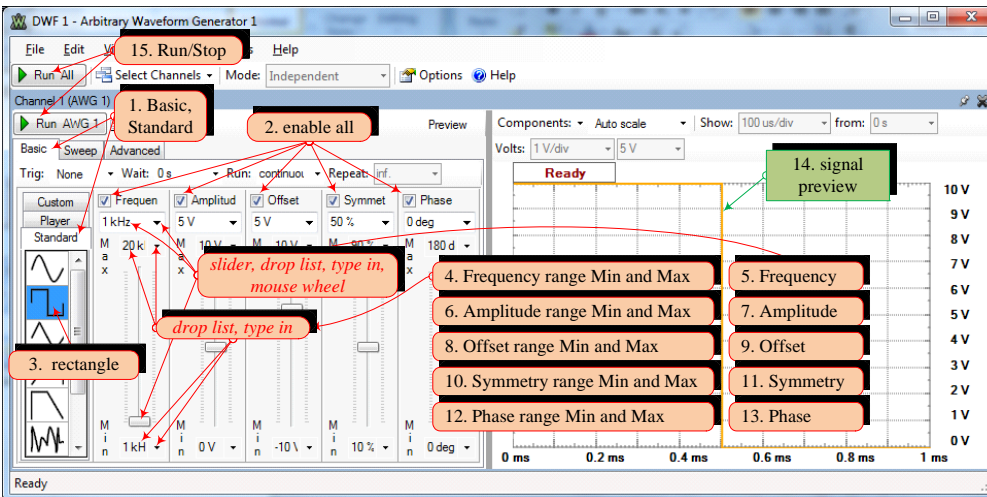
10. Set the scope for a good view of the excitation and output signals: Trigger Mode = Auto, Trigger Source = Channel 1, Trigger Cond. = Falling, Trigger Level = 5V, Time Position = 20us, Time Base = 5us/div, Channel and Channel 2 Offset = -6V, Range = 2V/div. Disable unused channels 3 and 4. Click Run.
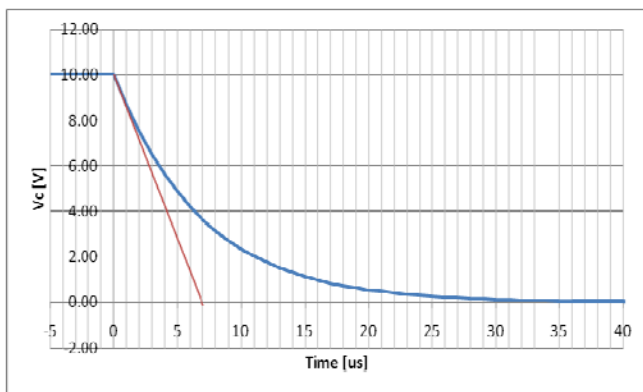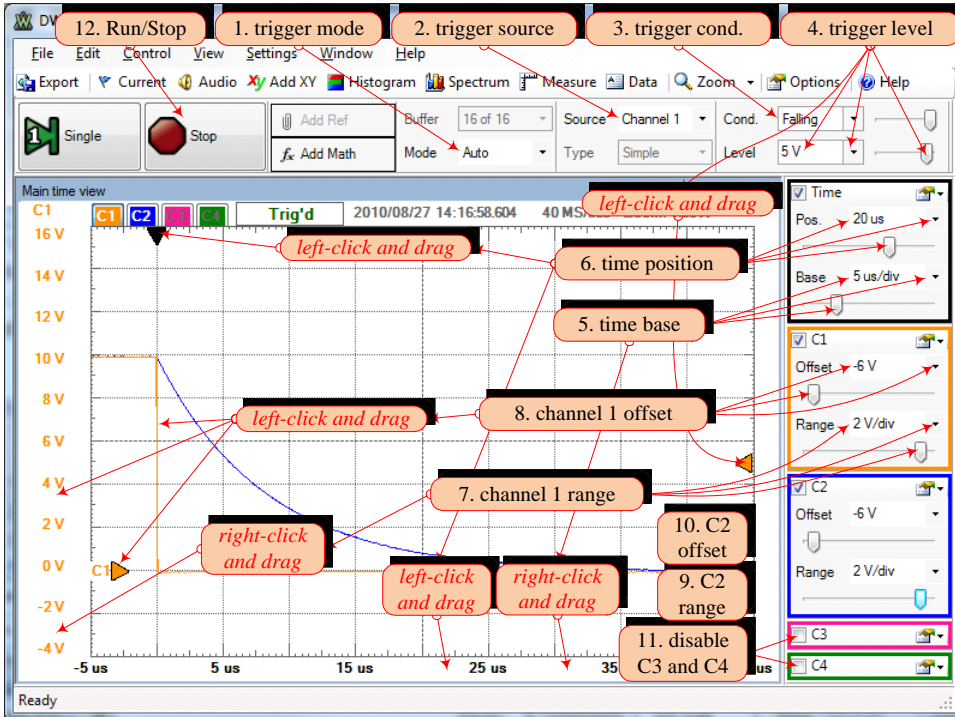
11. Note the signals.

Channel 1:

$$V_{in} = \begin{cases} V_{C0} = 10V \ for \ t < 0 \\ 0V \ for \ t \geq 0 \end{cases}$$

Channel 2:

$$V_C(t) = V_{in} + (V_{C0} - V_{in})e^{-\frac{t}{RC}}$$

12. Estimate $\tau = RC \cong 7\mu s$ time constant: a tangent to Vc(t) at t=0 would reach V_{in} at $t = \tau$.

To generate an RC circuit sine response showing the time domain:

1. Set the excitation signal: Shape = sine, Frequency = 20kHz, Amplitude = 8V, Offset = 0V, Symmetry = 50%, Phase = 0. Click Run All or Run AWG1.
2. Set the scope for a good view of the excitation and output signals: Trigger Mode = Auto, Trigger Source = Channel 1, Trigger Cond. = Rising, Trigger Level = 0V, Time Position = 0s, Time Base = 10us/div, Channel and Channel 2 Offset = 0V, Range = 2V/div. Disable unused channels 3 and 4. Click Run.

$$\varphi = \frac{HorizontalDeltaTime}{C1Period} \cdot 360[deg]$$

$$\left| \frac{V_c}{V_{in}} \right| = \frac{C2Amplitude}{C1Amplitude}$$

3. Note the signals.
4. Measure the signal parameters, using the Measurement window and Zoom View.
5. Close the Measurement and Zoom windows.
6. Open an XY view of Channel 2 versus Channel 1. Open a Spectrum view. Adjust the view size. In the Spectrum View, change Zoom = 50X
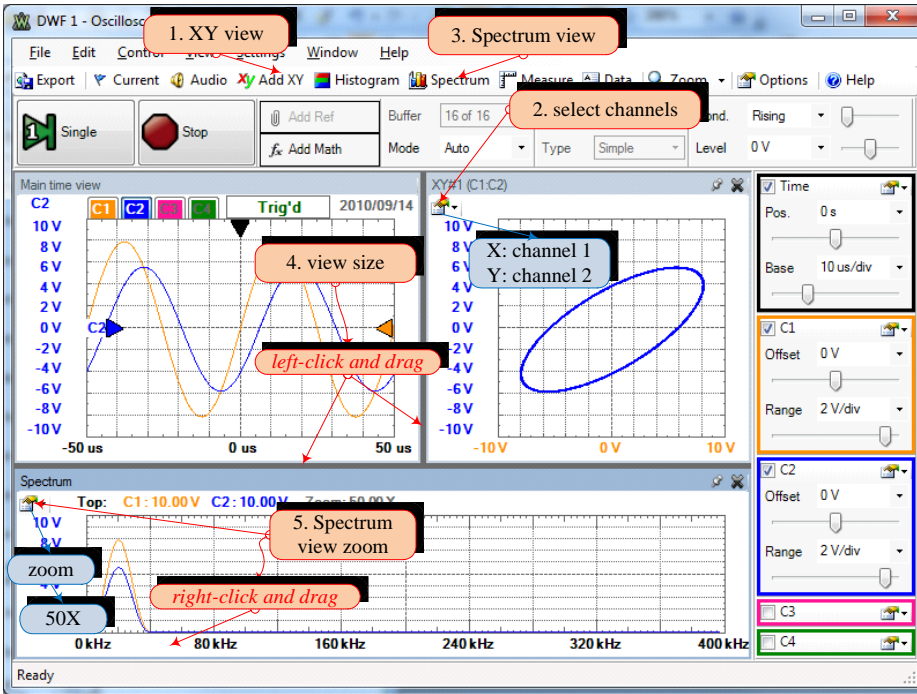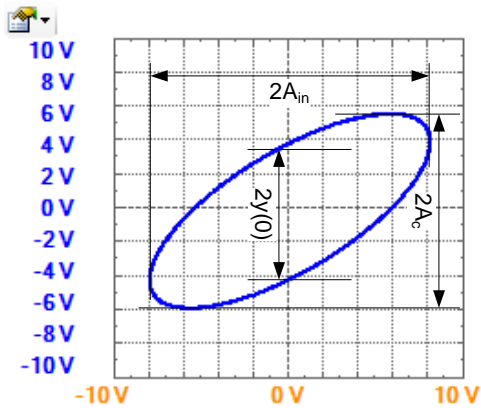

7. Export a View.
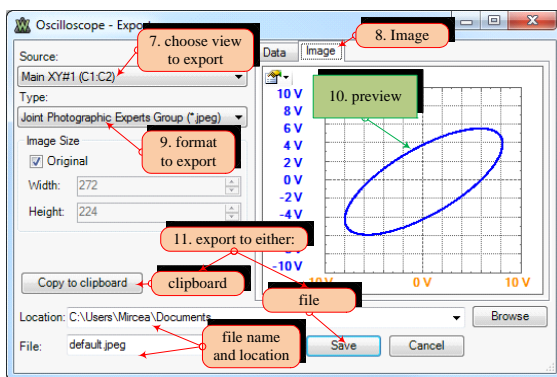
8. Measure the amplitudes and compute the phase shift on the XY view:

$$x(t) = V_{in}(t) = A_{in}\sin(2\pi ft)$$
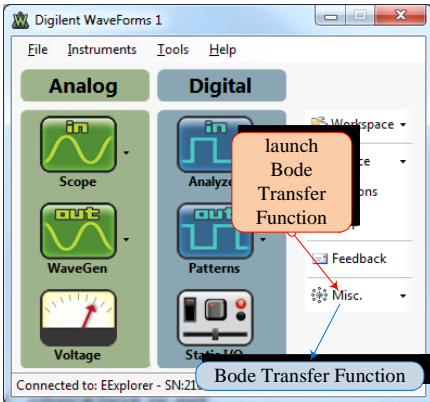
$$y(t) = V_C(t) = A_C\sin(2\pi ft + \varphi)$$

$$y(0) = V_C(0) = A_C\sin(\varphi)$$

$$\varphi = \arcsin\left(\frac{y(0)}{A_C}\right) = \arcsin\left(\frac{2y(0)}{2A_C}\right)$$

To generate an RC circuit sine response showing the frequency domain:

1. Launch the Bode Transfer Function.
2. Set the Bode Transfer Function for a good view of the RC circuit amplitude characteristic: Logarithmic 10 mode, End Frequency = 230kHz. Resize the window to get frequency values for all major grid lines. Click Run.

3. Note the amplitude characteristic.

$$\left|\frac{V_C}{V_{in}}\right| = \left|\frac{1}{1 + \dfrac{jf}{f_0}}\right| =$$

$$= \left|\frac{1}{1 + jf\left(2\pi\tau\right)}\right|$$

$$\left|\frac{V_C}{V_{in}}\right| = \left|\frac{1}{1 + \dfrac{jf}{f_0}}\right| = -3dB \ \ for \ f = f_0 = \frac{1}{2\pi\tau} \cong 23kHz$$