

# Simple RC Project for the Electronics Explorer Board

Revision: March 11, 2011

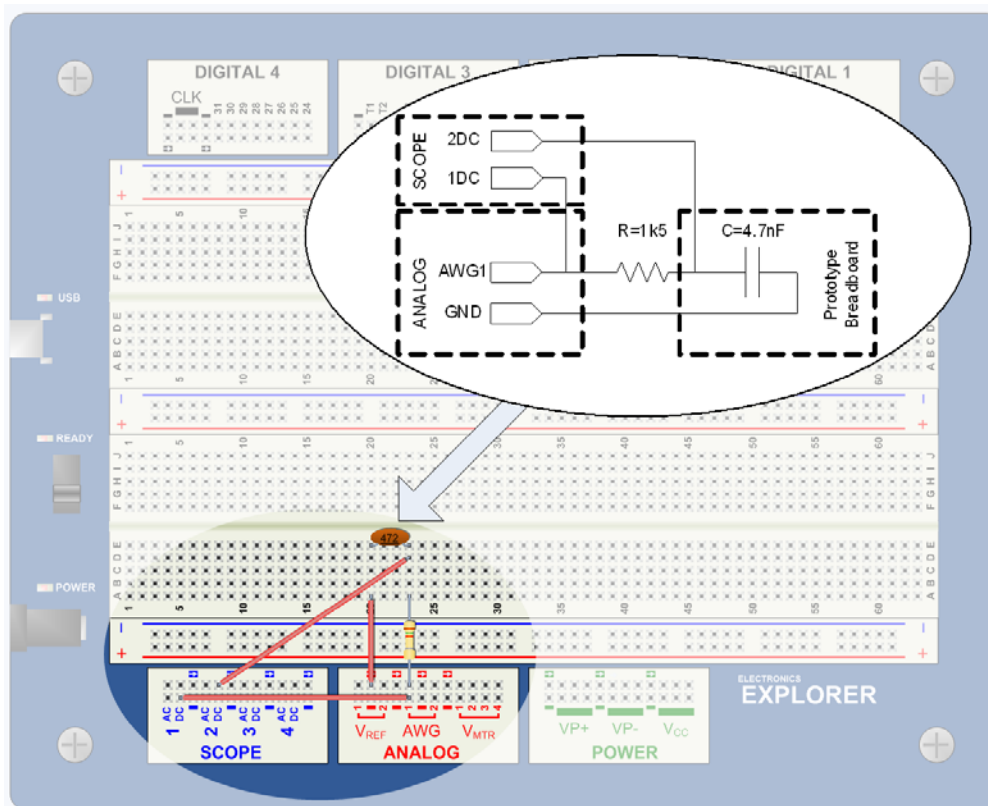
Note: This document applies to REV D&E of the board.



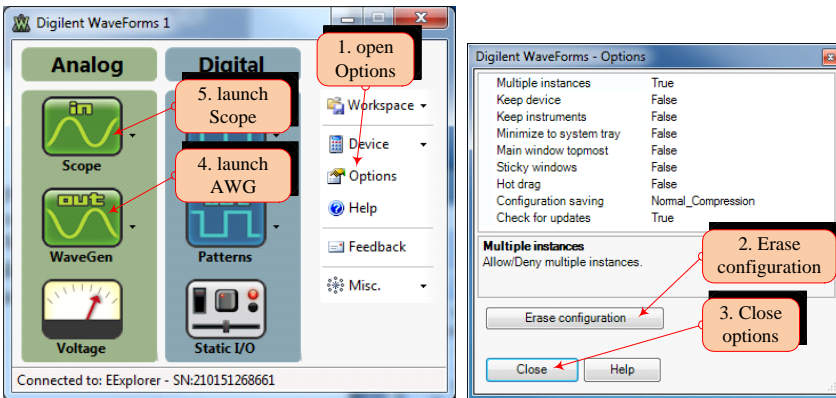
1300 NE Henley Court, Suite 3  
Pullman, WA 99163  
(509) 334 6306 Voice | (509) 334 6300 Fax

This project demonstrates some basic features of the Diligent 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.

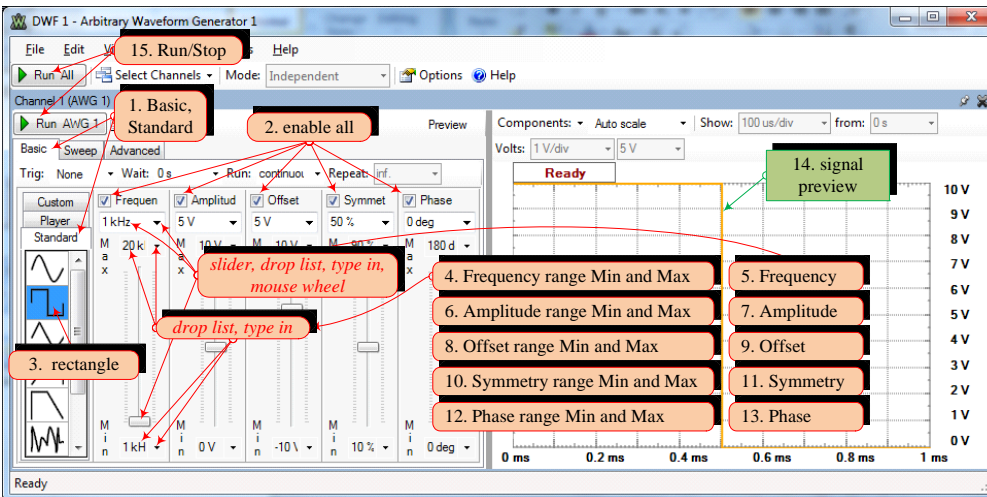
To generate an RC circuit step response showing the time domain:



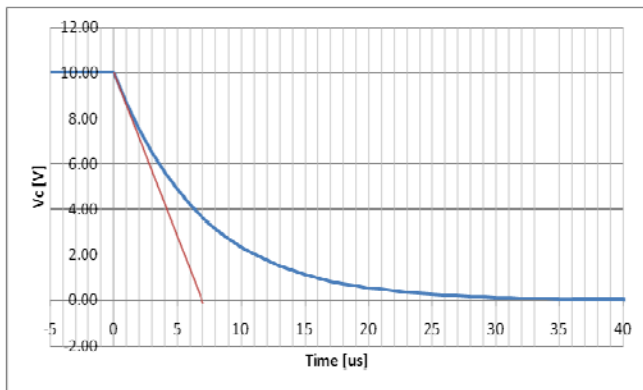
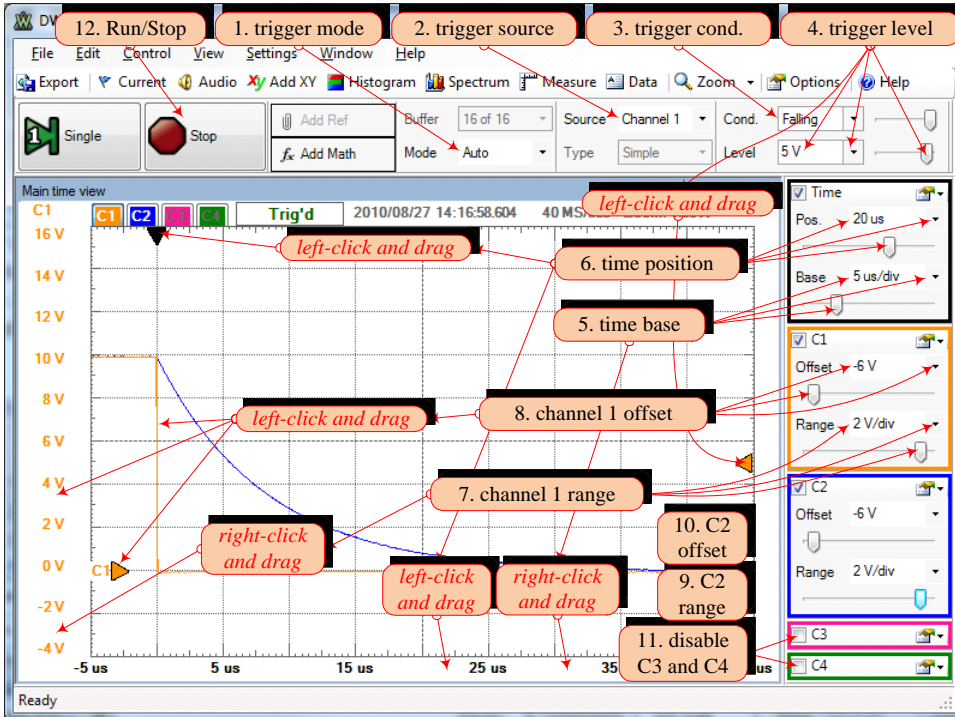
1. Build the schematic above.
2. Connect the EE Board to the PC with a USB micro AB cable.
3. Connect the board power supply.
4. Turn the On-Off switch ON.
5. Launch the WaveForms software.



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.



- 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.



- Note the signals.

Channel 1:

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

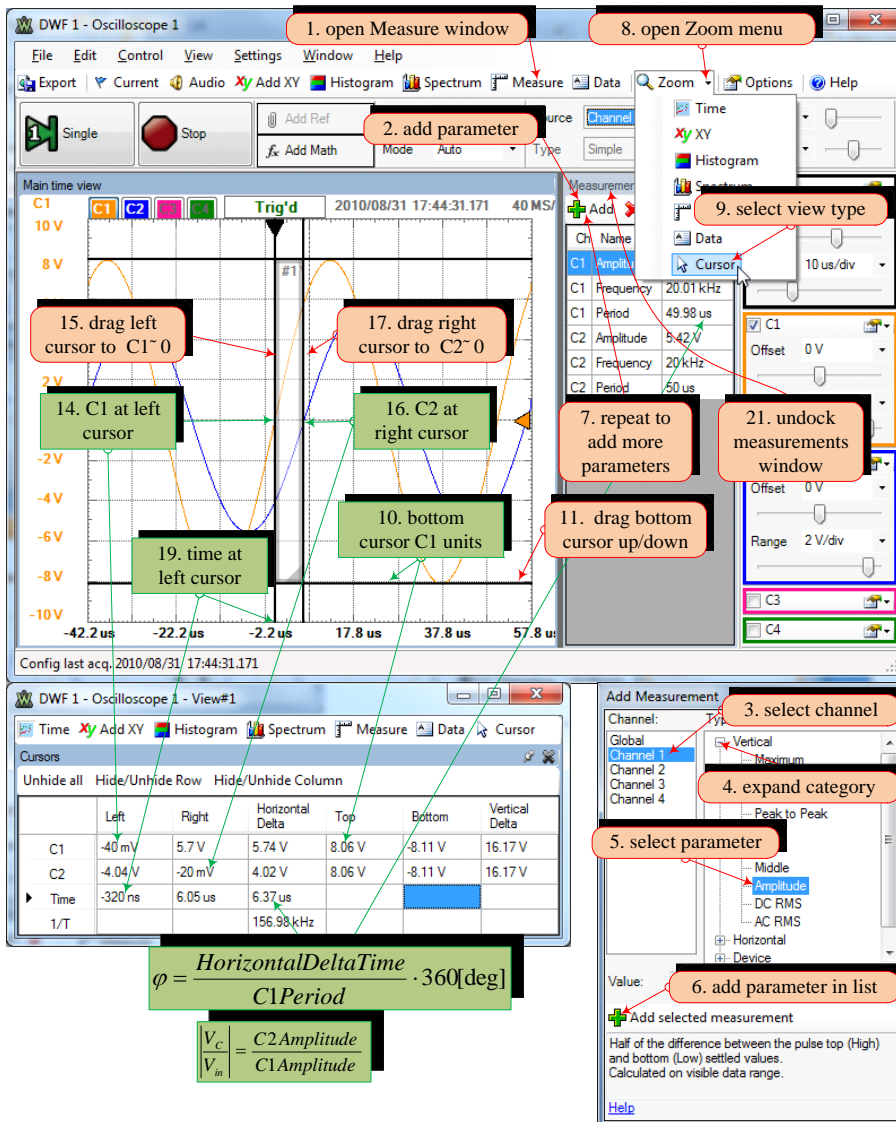
Channel 2:

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

12. Estimate  $\tau = RC \cong 7\mu s$  time constant: a tangent to  $V_c(t)$  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.



1. open Measure window

2. add parameter

3. select channel

4. expand category

5. select parameter

6. add parameter in list

7. repeat to add more parameters

8. open Zoom menu

9. select view type

10. bottom cursor C1 units

11. drag bottom cursor up/down

12. drag left cursor to C1=0

13. C1 at left cursor

14. C1 at left cursor

15. drag left cursor to C1=0

16. C2 at right cursor

17. drag right cursor to C2=0

18. C2 at right cursor

19. time at left cursor

20. time at left cursor

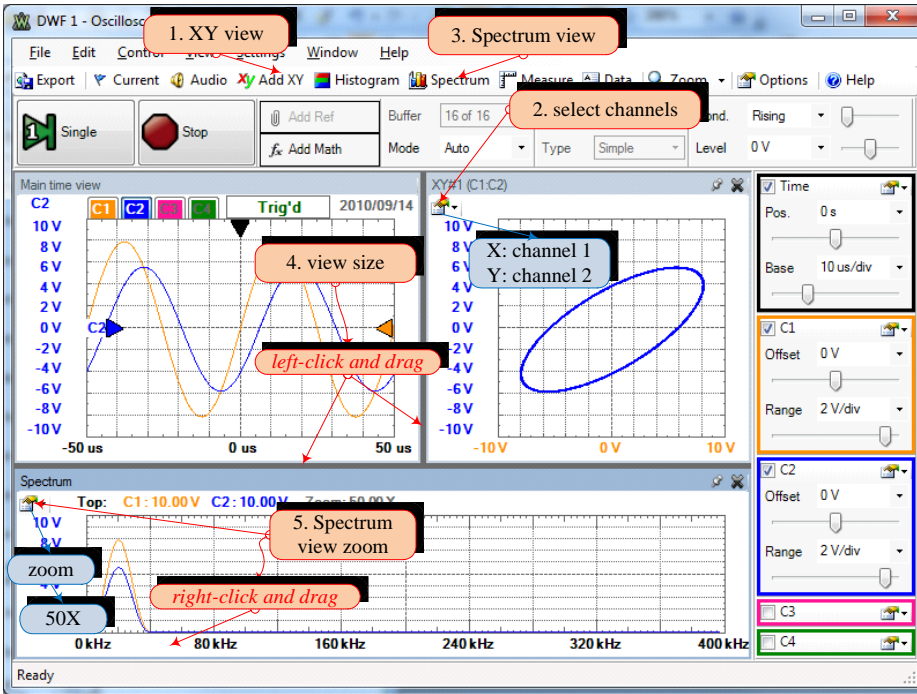
21. undock measurements window

	Left	Right	Horizontal Delta	Top	Bottom	Vertical Delta
C1	-40 mV	5.7 V	5.74 V	8.06 V	-8.11 V	16.17 V
C2	-4.04 V	-20 mV	4.02 V	8.06 V	-8.11 V	16.17 V
Time	-320 ns	6.05 us	6.37 us			
1/T			156.98 kHz			

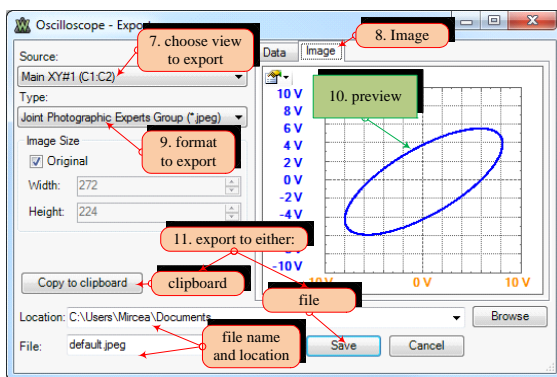
$$\phi = \frac{\text{HorizontalDeltaTime}}{\text{C1Period}} \cdot 360[\text{deg}]$$

$$\frac{V_c}{V_{in}} = \frac{\text{C2Amplitude}}{\text{C1Amplitude}}$$

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.



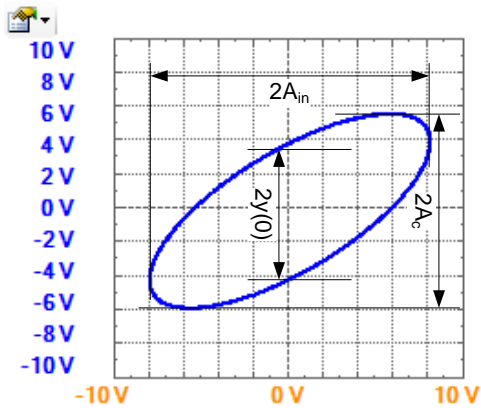
8. Measure the amplitudes and compute the phase shift on the XY view:

$$x(t) = V_{in}(t) = A_{in} \sin(2\pi ft)$$

$$y(t) = V_C(t) = A_C \sin(2\pi ft + \varphi)$$

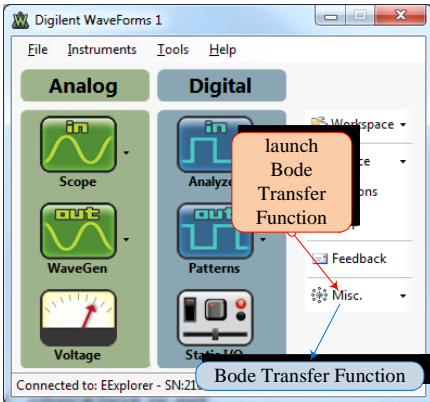
$$y(0) = V_C(0) = A_C \sin(\varphi)$$

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



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.

$$\left| \frac{V_C}{V_{in}} \right| = \left| \frac{1}{1 + \frac{jf}{f_0}} \right| = \left| \frac{1}{1 + jf(2\pi\tau)} \right|$$

