

# Introductory Project for the Electronics Explorer Board



Revision: March 11, 2011

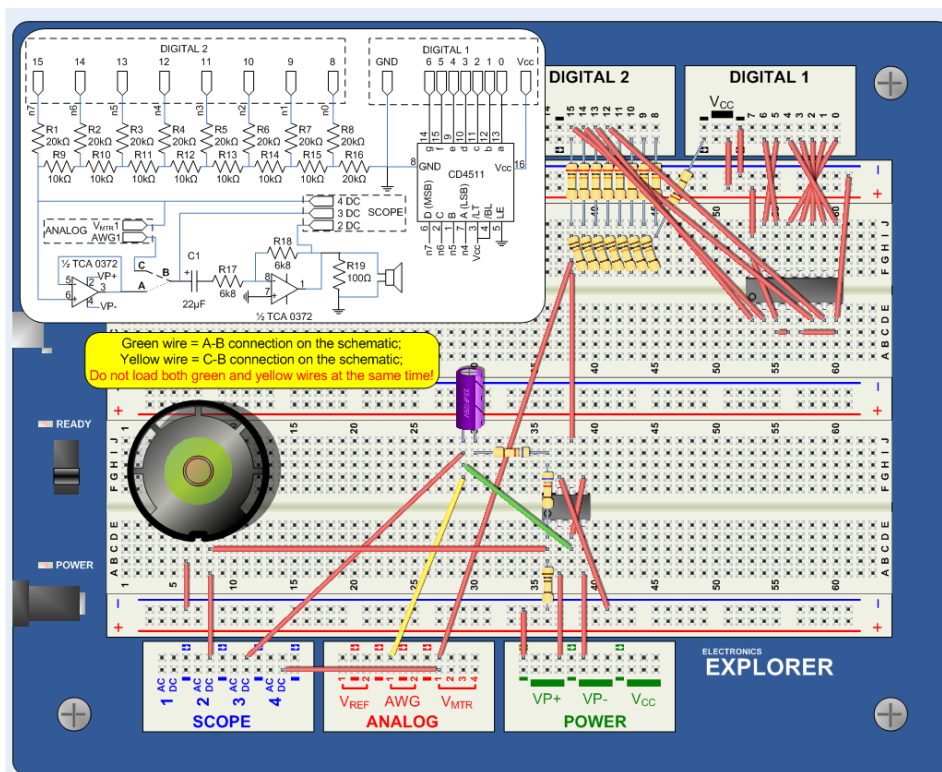
Note: This document applies to REV D&E of the board.

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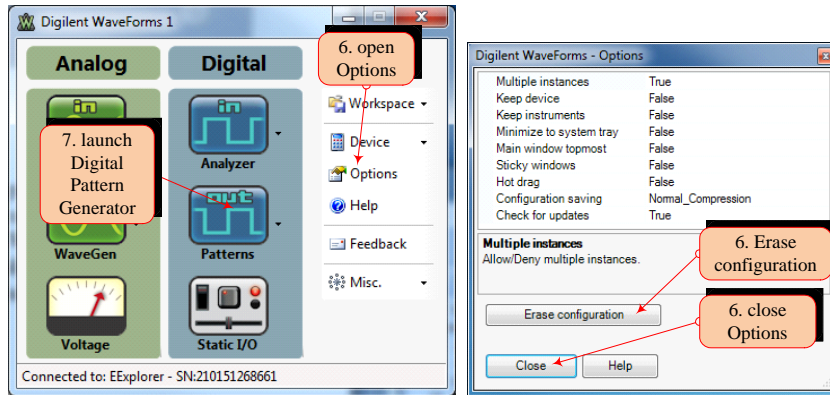
This project demonstrates some basic features of the Digilent Electronics Explorer Board. Using a few electronic components, the project introduces the six instruments in the WaveForms software: Scope, Arbitrary Waveform Generator, Power Supply and Voltmeter, Logic Analyzer, Digital Pattern Generator, and Static I/O. To keep the project simple for new users, only a few features of the software are used.

## To generate digital signals:

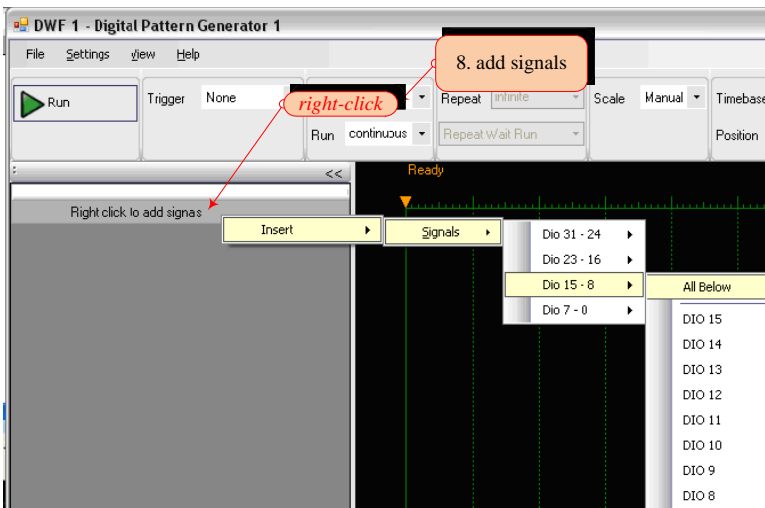
1. Build the schematic below (you can build it later or only add parts of the schematic as described).



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 and confirm in the dialog window. Close the Options window if it does not close automatically.

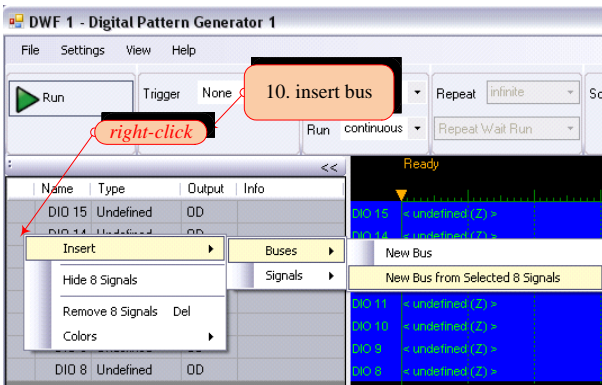


7. Launch the Digital Pattern Generator.
8. Configure an 8-bit bus. Right-click in the signal name field then select Insert > Signals > DIO15-8 > All Below.

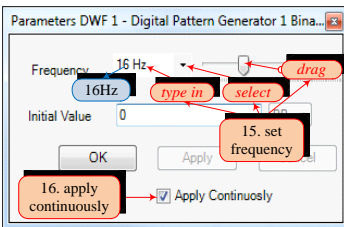


9. Select all signals (click and press the Shift or Ctrl keys.)

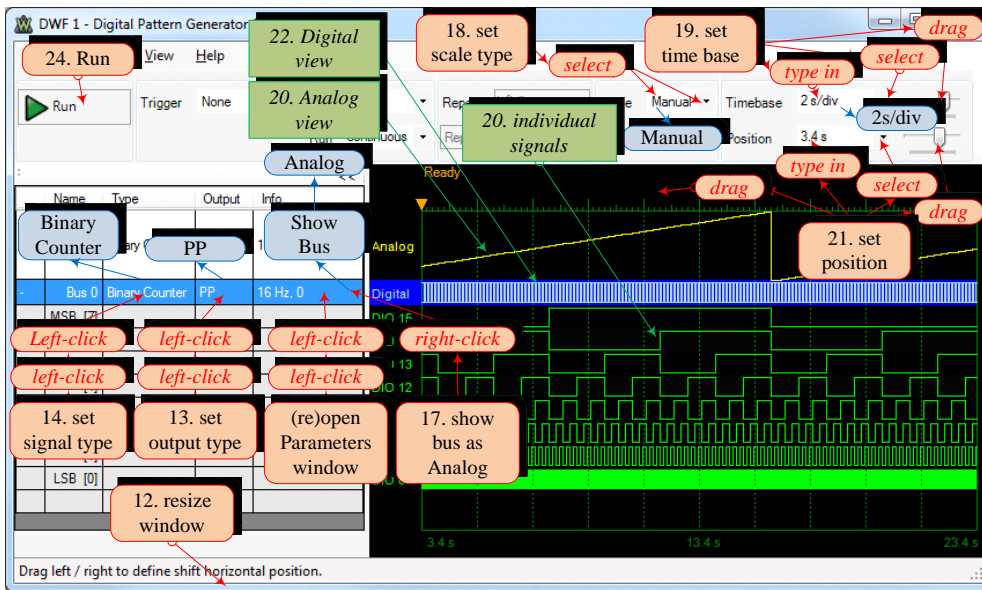
- Right-click in the selected signal area then select Insert > Buses > New Bus from the selected eight signals.



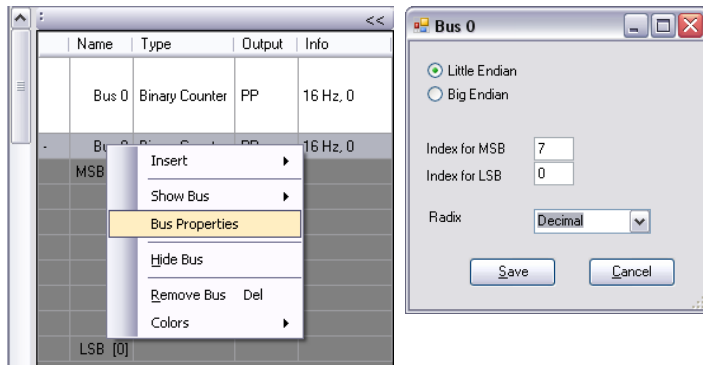
- Click + to expand the bus.
- Resize the window to fit all signals.
- Change Output type from OD (Open Drain) to PP (Push-Pull).
- Change Type from Undefined to Binary Counter.
- In the Parameters window, set frequency to 16Hz.



- Make sure that the Apply Continuously checkbox is set.
- Right-click on Bus 0 and select Show Bus > Analog.
- Set Scale to Manual.
- Set Time Base to a convenient value (about 2s/div).



20. Note in Preview the individual signals in the bus and the analog representation of the bus.
21. Set Scale to Manual and Time Base to a convenient value (about 50ms/div). Change Position to browse the signal sequence in time. You can use the Position control, the associated cursor, or click and drag in the field above the graphical area.
22. Note in Preview the bus values in the graphical area and the digital representation of the bus values.
23. Right-click on Bus 0 and select Bus Properties. Confirm Yes in the dialog window. Choose Endianness, Index Range, and Radix as desired. Confirm with Save.



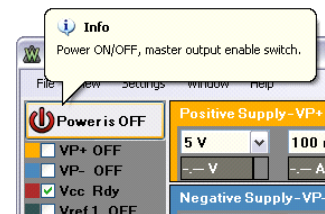
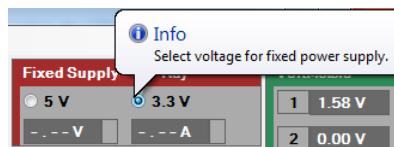
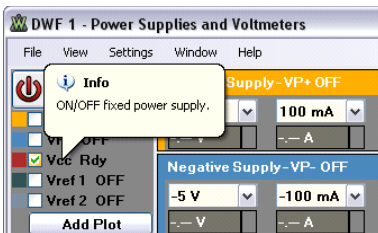
24. Run the Digital Pattern Generator.

**To create a digital circuit prototype:**

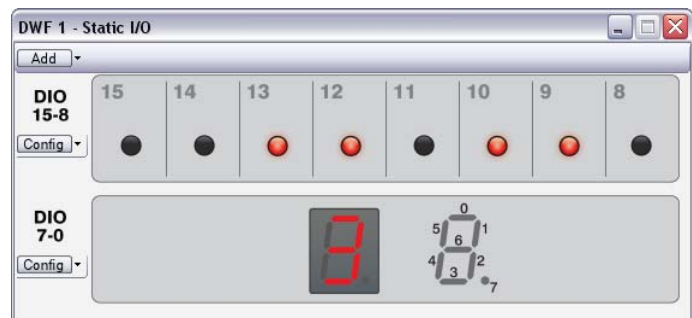
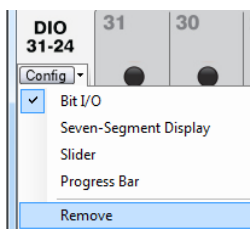
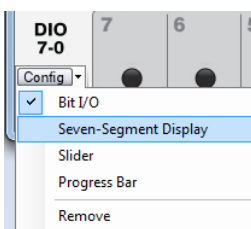
1. Build the BCD to seven-segment decoder schematic on the breadboard.
2. Turn the EE Board switch off. That will disable all the signals on the board to prevent circuit damage during prototype building.
3. Load the IC and wires to connect to power supplies and input/output signals. Keep in mind that you will use Digital 2 breadboard signals (DIO15-8) as outputs (generated by the onboard instruments) and inputs (to observe behavior), and Digital 1 breadboard signals (DIO7-0) as inputs only.
4. Check connections and turn the EE Board switch on.
5. Launch the Power Supply and Voltmeter instrument.



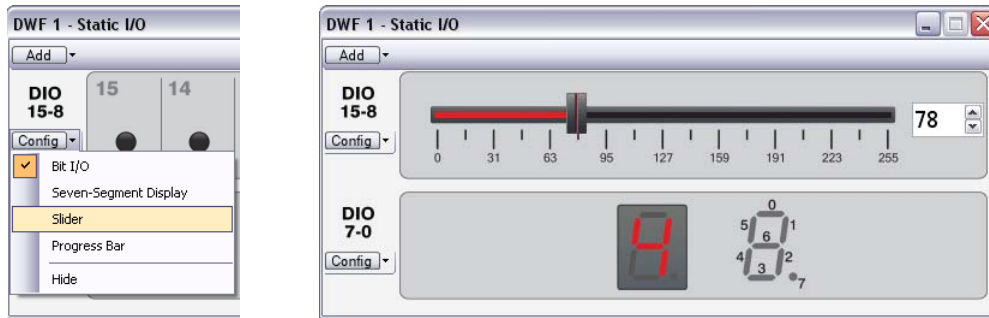
6. Check the Vcc power supply and uncheck all the other power supplies and reference voltages. Set Vcc to 3.3V. Turn the power ON.



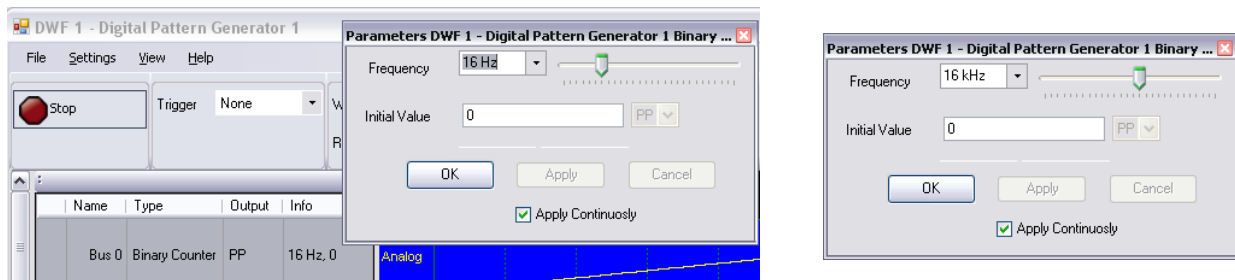
7. Launch the Static I/O.
8. Configure DIO7-0 as a seven-segment display. Remove DIO31-24 and DIO23-16.
9. Make sure that the Digital Pattern Generator has the same settings as described before and is still running.



10. Note that the eight bits generated by the Digital Pattern Generator are shown on DIO15-8 LEDs in the Static I/O. The most significant four bits are also decoded for a seven-segment display (by the prototype circuit you built) and shown on the DIO7-0 display in the Static I/O. Note that the binary counter generated by the Digital Pattern Generator counts hexadecimal while the BCD to seven-segment decoder only decodes the legal BCD values and blanks for A...F.
11. Configure DIO15-8 as a slider. Click and drag the slider or use the numeric field to change the value.



12. Note that the Digital Pattern Generator, Logic Analyzer, and Static I/O instruments share the same DIO31-0 digital signals. The Logic Analyzer uses these signals as inputs only, so it never interferes with output instruments sharing the same signals. The Digital Pattern Generator uses these signals as outputs, meaning it will actively drive the inserted signals as set. The Static I/O can be set to use these signals as inputs (LEDs, progress bar, or seven-segment display) or outputs (slider, push buttons, or switches). For signals configured as outputs, the Static IO takes precedence over the Digital Pattern Generator.
13. To use the Digital Pattern Generator as the source for DIO15-8 again:
  - configure DIO15-8 as all inputs (progress bar, seven segment display or Bit I/O LED), or,
  - turn off the Static I/O instrument.
14. In the Digital Pattern Generator, change the clock frequency for the binary counter to 16kHz:
  - double-click in the Info area of Bus 0
  - in the Parameters window, type 16 kHz for frequency.

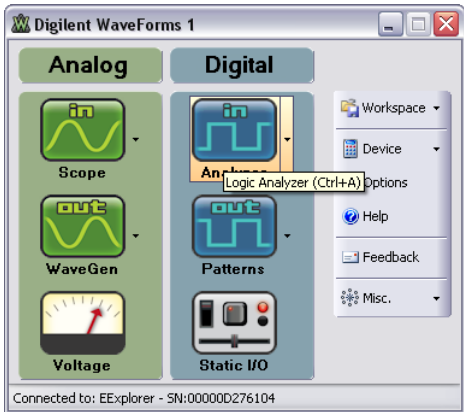


15. Note that the Static I/O instrument is not able to show signals at this frequency, because neither the PC display nor human sight are fast enough.

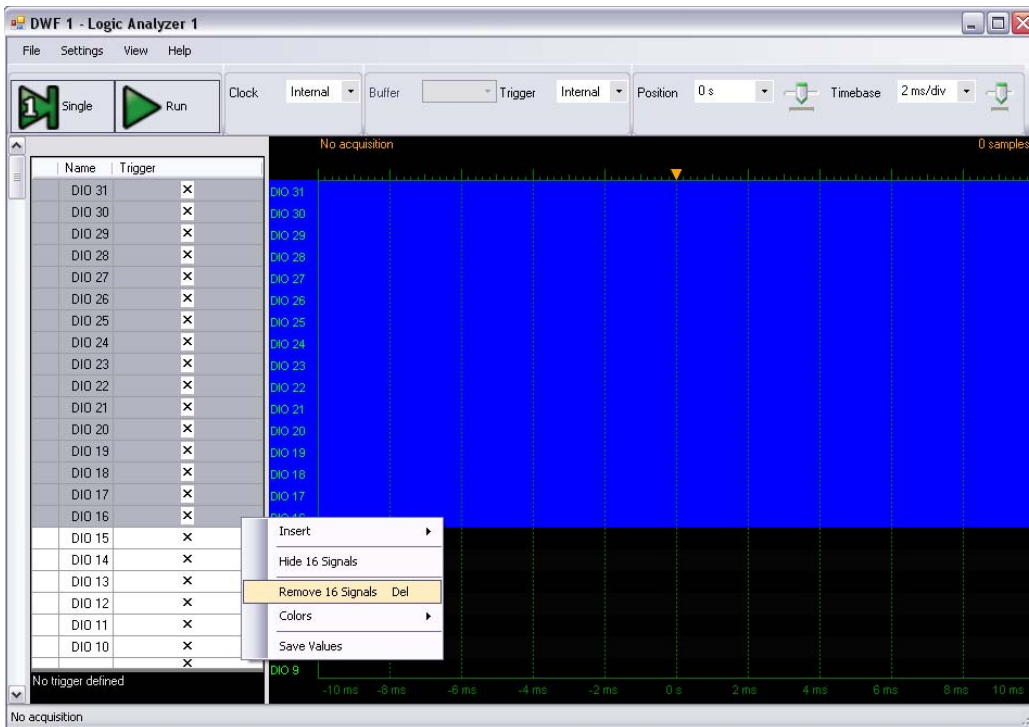


**To acquire digital data:**

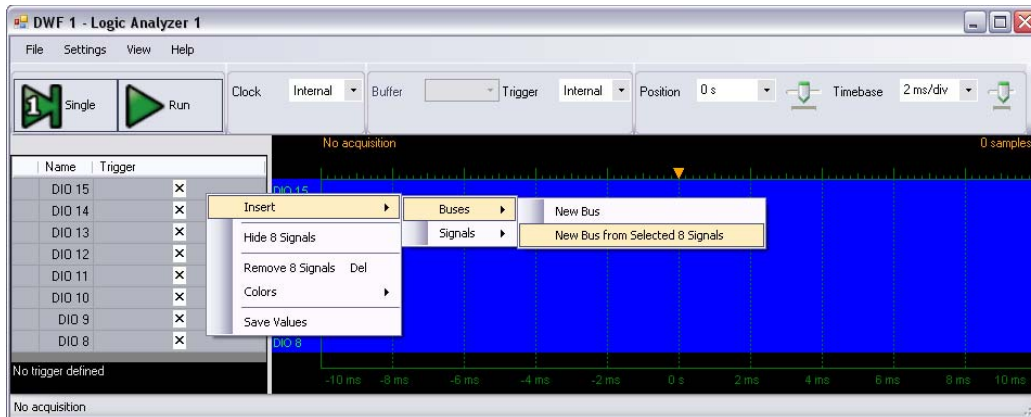
1. Launch the Logic Analyzer.



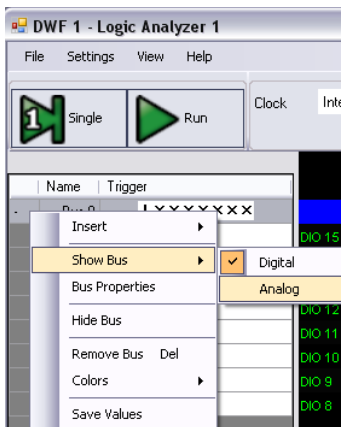
2. Set an 8-bit bus to acquire the Digital Pattern Generator signals. Keep only DIO15- DIO8.
3. Select the unneeded signals (click and press the Shift or Ctrl key).
4. Right-click in the selected signal name field and select Remove XX Signals.



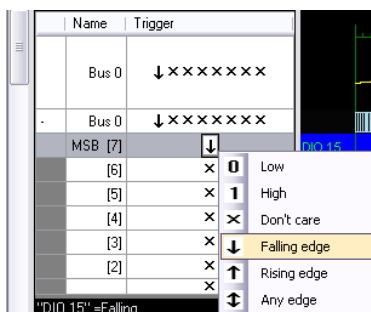
5. Select all used signals (click and press the Shift or Ctrl key.)
6. Right-click in the selected signal area.
7. Select Insert > Buses > New Bus from the selected eight signals.



8. Click + to expand the bus.
9. Right-click on Bus 0 and select Show Bus > Analog.



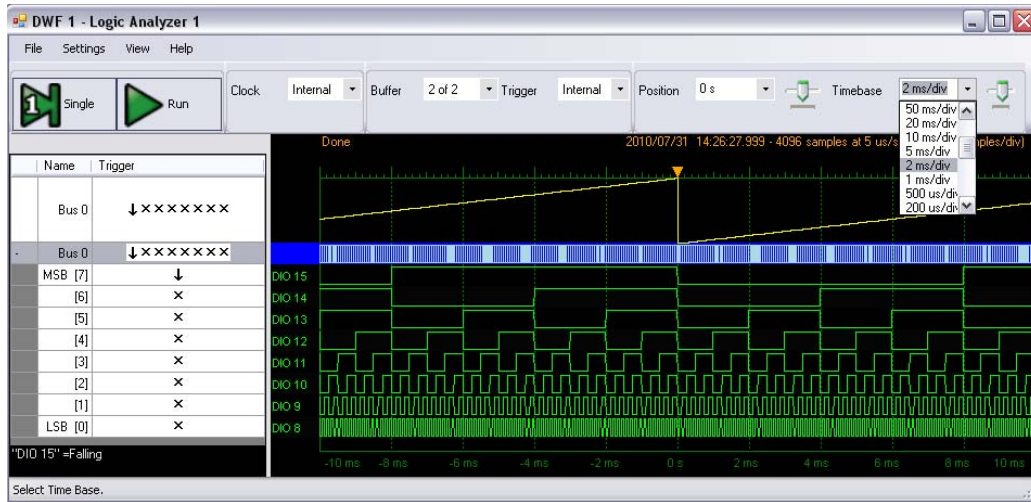
10. Set the trigger condition to falling edge of the MSB. Right-click on the X corresponding to MSB (either in the collapsed or expanded bus) and select Falling Edge. Or you can left-click the same spot as many times as needed to get the symbol for falling edge.



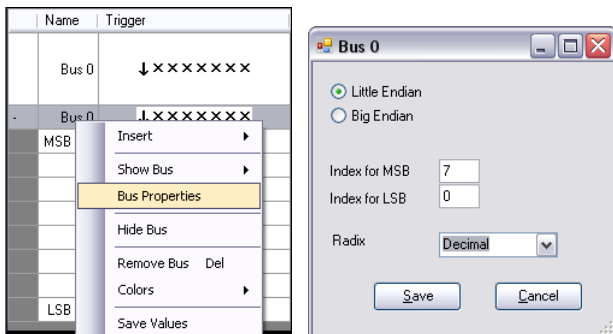
11. Set Time Base to a convenient value (about 2ms/div). Click Run.



12. Note that the acquired data is shown as individual signals in the bus and note the analog representation of the bus values.
13. Click and drag the Trigger Event sign (the orange triangle on top of the graphical area) to change the trigger position. The Logic Analyzer acquires data before and after the trigger event as needed to fill the graphical field. The trigger event can even be positioned outside the graphical field.

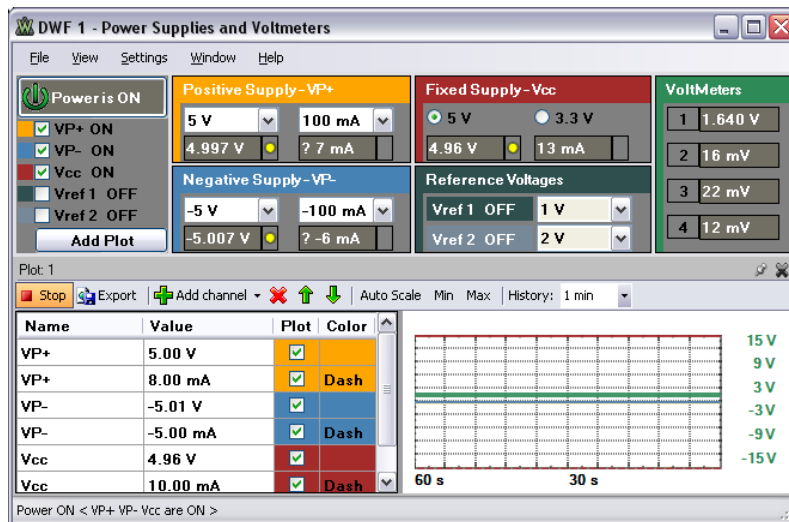


14. Set Time Base to a convenient value (about 50us/div). Change Position to browse the signal sequence in time.
15. Note in Preview the bus values in the graphical area and the analog representation of the bus values.
16. Right-click on Bus 0 and select Bus Properties. Choose Endianness, Index Range, and Radix as desired.

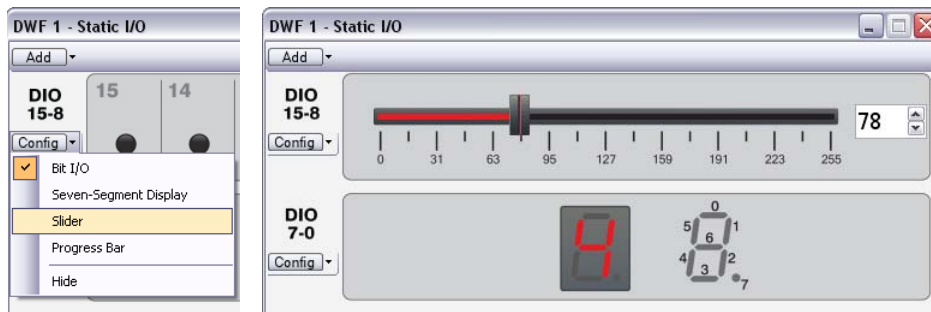


### To build an R-2R resistor network:

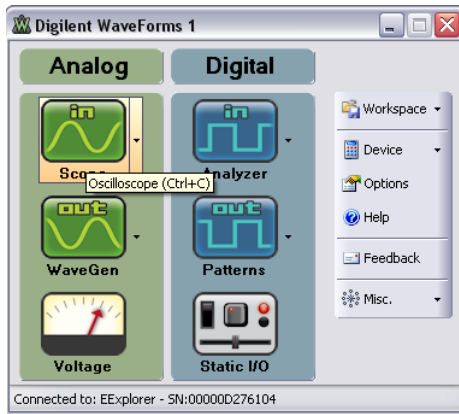
1. Build the R-2R schematic on the breadboard as shown at the beginning of this document.
2. Turn the EE Board switch off. That will disable all the signals on the board to prevent circuit damage during prototype building.
3. Load the resistors and wires to connect to power supplies and input/output signals. Keep in mind that you will use Digital 2 breadboard signals (DIO15-8) as outputs (generated by the onboard instruments) and inputs (to observe behavior), and Digital 1 breadboard signals (DIO7-0) as inputs only.
4. In the Power Supplies and Voltmeters window, turn the Power OFF.
5. Set VP+ to 5V, VP- to -5V, and Vcc to 3.3V.
6. Set the current limits for VP+ and VP- to 100mA.
7. Enable VP+, VP-, and Vcc.
8. Turn the Power ON.



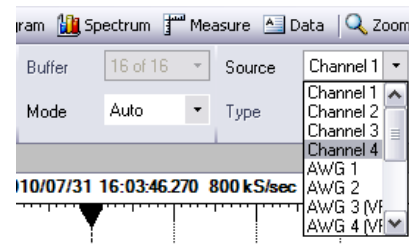
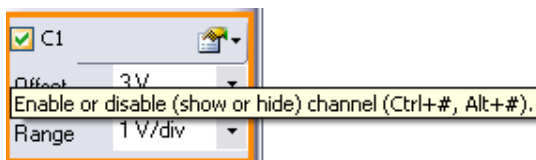
9. Check the connections and turn on the EE Board switch.
10. Launch Static I/O again and configure DIO15-8 as a slider. Click and drag the slider or use the numeric field to change the value.



11. Note the R-2R resistor network output voltage displayed on Voltmeter 1 in the Power Supplies and Voltmeters window. As you drag the slider from 0 to 255, the voltage changes from 0 to 3.3V.
12. Turn off the Static I/O instrument (for Digital Pattern Generator to take control of DIO15-8).
13. Launch the Scope.

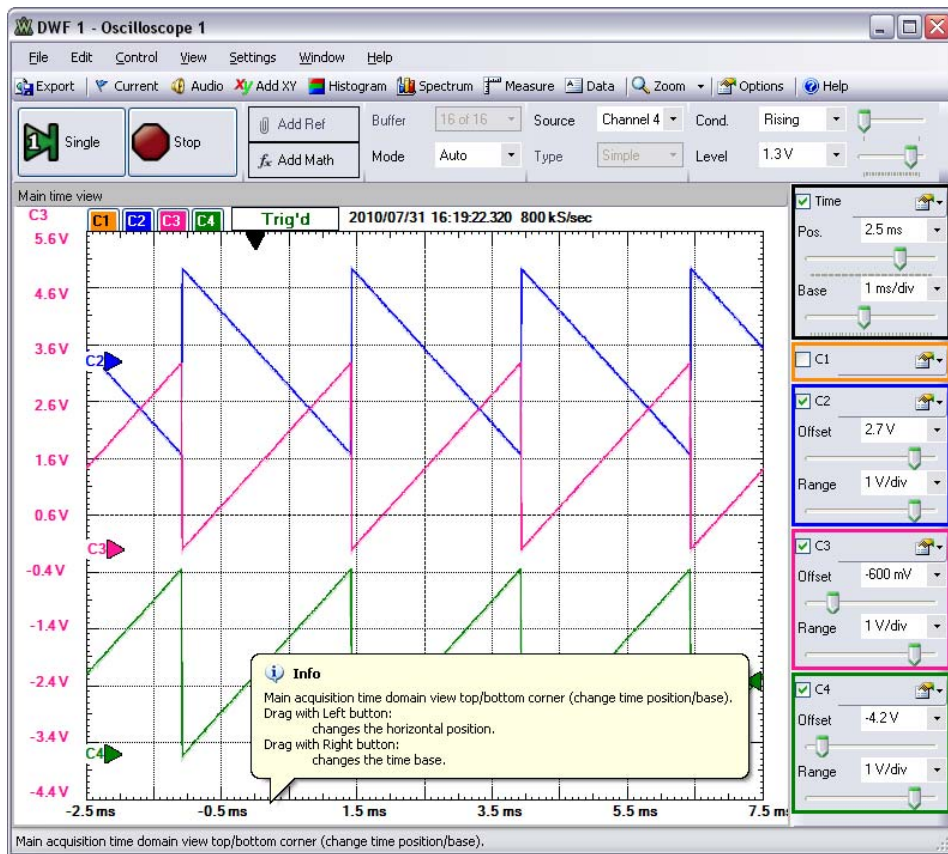
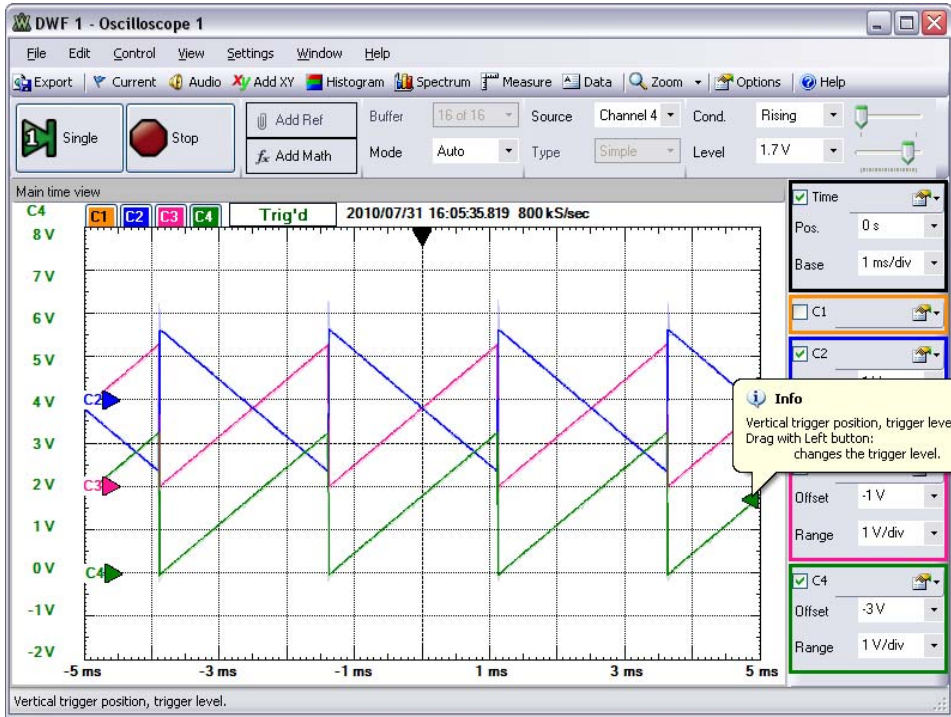


14. In the Digital Pattern Generator, change the clock frequency for the 8-bit bus to 102.4 kHz. The 8-bit binary counter will cycle at 400Hz. Make sure the Digital Pattern Generator is running.
15. Configure the scope to acquire the R-2R resistor network output signal on Channel 4.



16. Disable the unused Channel 1.
17. Set Channel 4 as the trigger source.
18. Set the Scope as in the figures below.
19. Click Run.

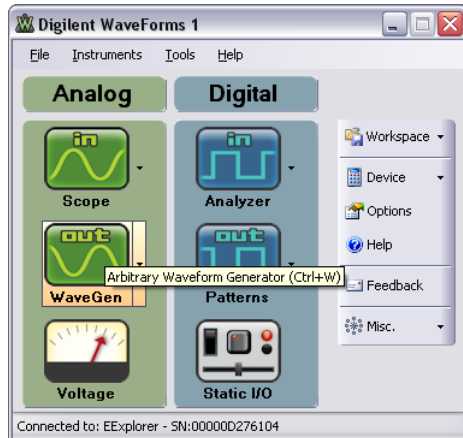
20. Click and drag the trigger level symbol for a stable image.



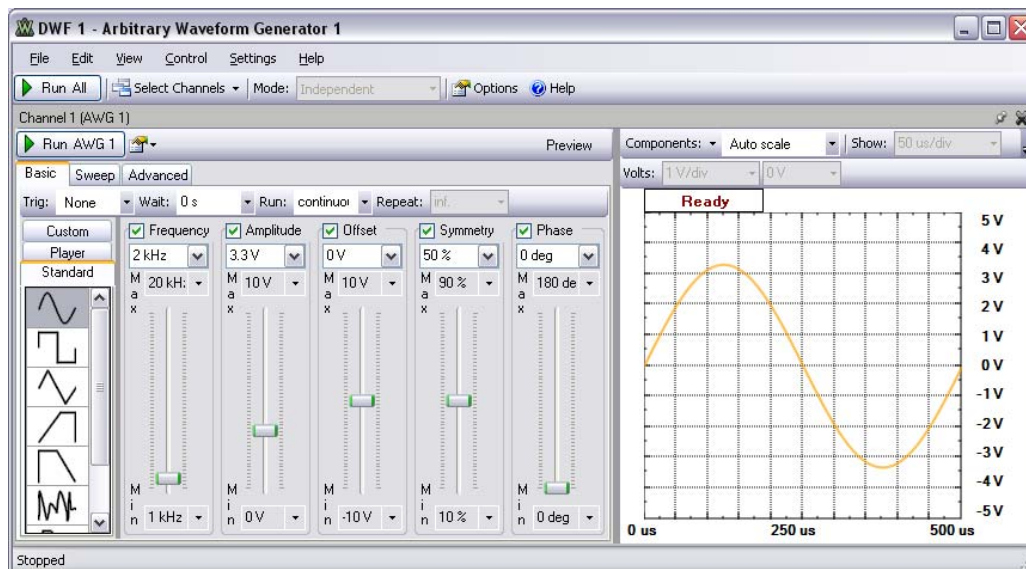
21. Adjust the Horizontal Position, Time Base, Offset, and Range for each channel as desired. Use the numerical controls or enlarge the Scope window to get sliders for each control. Move the mouse cursor over the Scope window and stop to get hints about what you can do with the mouse.
22. Note the analog signals on the Scope and note the sound in the speaker (a metallic A for a 400Hz triangle).

### To create sound effects:

1. Connect AWG1 to the audio prototype circuit.
2. Turn the EE Board switch off.
3. Disconnect the second stage OA from the first stage and connect it to the AWG1.
4. Turn the EE Board switch on.
5. Launch the Arbitrary Waveform Generator (AWG).

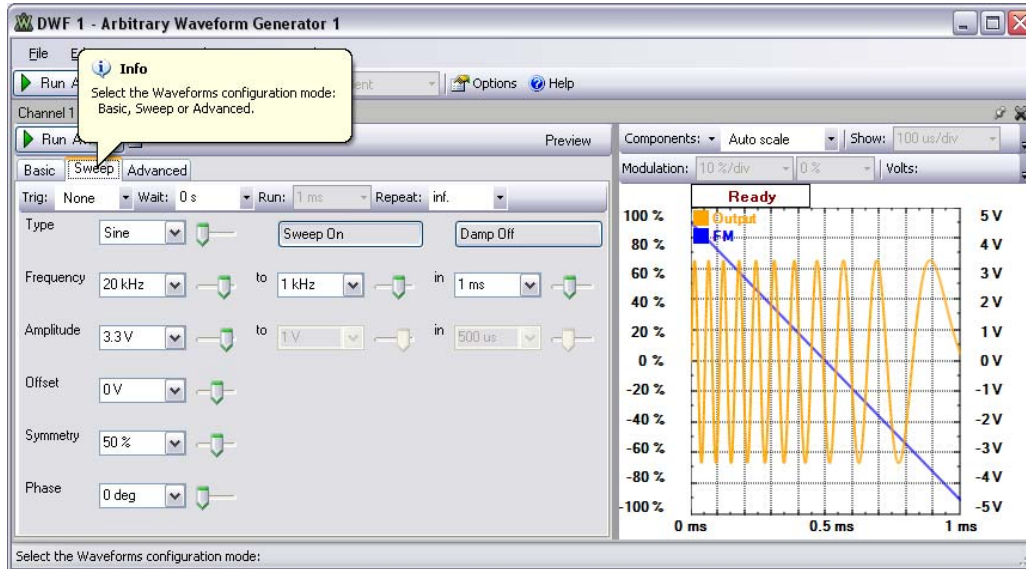


6. In the Power Supplies and Voltmeters window, make sure that  $V_{p+}$ ,  $V_{p-}$ , and  $V_{cc}$  are set as described above and enabled. Make sure that Power is ON.
7. To generate simple signals, select the Basic Mode tab.
8. Click Run All or Run AWG1. Change the frequency, amplitude, and wave shape.
9. Note the scope image and audio signal in the speaker. Note that signals might be distorted (i.e., limited amplitude).

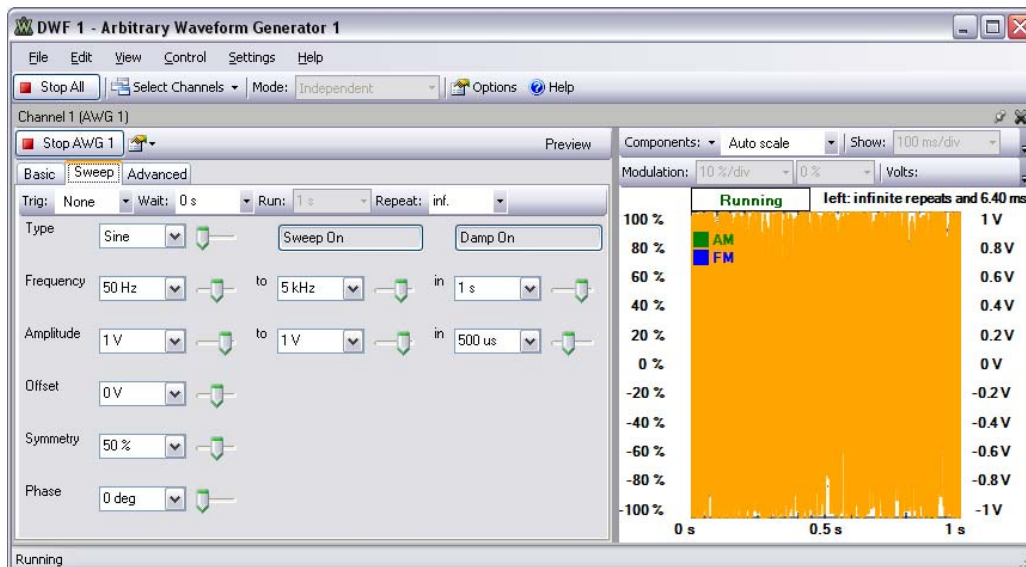




10. To generate swept signals, select the Sweep mode tab.
11. Click Run All or Run AWG1. Change the frequency, amplitude and wave shape.
12. Turn Sweep On to get signals with linear frequency variation.
13. Turn Damp On to get signals with linear amplitude variation.

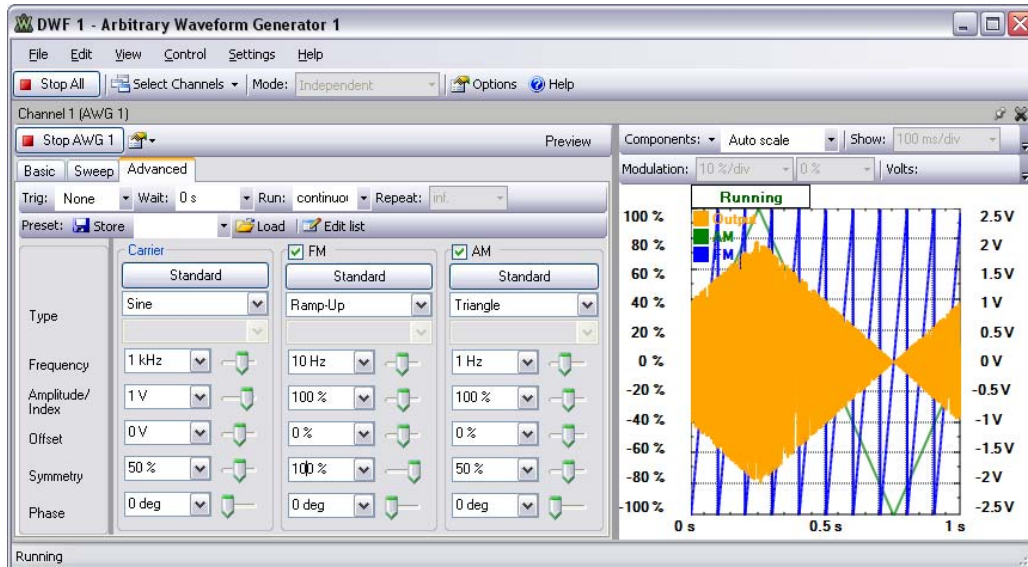


14. Set the AWG as shown below for an interesting sound effect. Change the settings to create others.
15. Note the scope image and audio signal. Note that signals might be distorted (i.e., limited amplitude). You might need to adjust the scope settings (time base, amplitude, and triggering) to get a coherent image.



16. To generate modulated signals, select the Advanced mode tab.
17. Click Run All or Run AWG1. Change the frequency, amplitude, and wave shape.
18. Check FM to get Frequency Modulated signals.
19. Check AM to get Amplitude Modulated signals.

20. Set the AWH as in the image below for an interesting sound effect. Change the settings to create others.
21. Note the scope image and audio signal. You might need to adjust the scope settings (time base, amplitude, and triggering) to get a coherent image.



22. To play a .wav file, select the Basic mode tab, then select the Player tab.
23. Click the Add icon. Browse and select the .wav file to play.
24. You can add more files in the play list.
25. Note the file info above the file list (size and sampling frequency). To play the file at the original speed (pitch), set the frequency to the value shown by the file info (type in the numerical control).
26. Click Run AWG1 or Run All to play the file.
27. Note the Scope image and audio signal. Note that signals might be distorted (i.e., limited amplitude). You might need to adjust the scope settings (time base, amplitude, and triggering) to get a coherent image.
28. Adjust the Amplitude for volume control.
29. Adjust the Frequency to create interesting effects.

